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# SOLUBILITIES

OF

INORGANIC AND ORGANIC COMPOUNDS

*A Compilation of Quantitative Solubility  
Data from the Periodical Literature*

*By*

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## PREFACE

The principal object in preparing a compilation of solubility data, from the point of view of the advancement of chemistry, is to furnish material for the origination and verification of theories of solution. The majority of investigators who have been engaged on such problems, have been compelled to determine experimentally the values required for developing the generalizations they hoped to establish. In fact, a large part of the most accurate data which are here brought together, are the outgrowth of such studies. It is hoped, therefore, that the present effort to make these and all other quantitative results more accessible for theoretical studies of solubility, will lead to noteworthy advances in this field of chemistry.

Of the various properties which determine the uses of compounds in a chemical way, solubility is of first importance. Therefore, solubility data are perhaps of even greater interest from a practical than from a theoretical point of view. For this reason it has been necessary to consider the needs of those who require such information only incidentally and may, therefore, be less familiar with some of the forms used for its expression. With this in mind, and at the suggestion of users of the preceding edition, chapters have been prepared in which are described, among other things, the sources of solubility data, the methods of calculating them to desired terms, the interpretation of their tabular arrangement, as well as some of the methods used for the accurate determination of solubilities.

Soon after the previous edition was issued, the collection of the new data, to be used in keeping the subject matter up to date, was systematically begun. In doing this, the experiment was made of examining each journal page by page, instead of scanning the titles of original papers contained in it. This resulted in the discovery of many data that would otherwise have been overlooked, and it soon became apparent that a more careful search of the literature than that previously made was necessary. It was, therefore, decided not only to examine the current periodicals minutely, but to go through the back volumes in a manner equally as thorough. The data collected in this way soon amounted to more than could be advantageously added as a supplement to the tables in the first edition, and it was decided to wait until the whole book could be completely rearranged, before making any additions



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to the subject matter. It also appeared advisable to extend the scope to include freezing-point and certain other data, which had been omitted entirely from the first edition. The undertaking, therefore, developed far beyond the original expectation of regularly adding, from year to year, the new data which would keep the compilation up to date. Since the amount of time at my disposal for this work was limited, progress necessarily has been slow. Finally, the advent of the war extended the period far beyond the limit caused by other conditions.

Although the compilation has now been completed, I realize that in a work of this kind, more satisfactory results would have been achieved if several individuals had coöperated in its preparation. The recent decision of the American Chemical Society to extend its activities to the publication of reference books, will, I hope, insure that hereafter, compilations of the present character will be made in the exceptionally thorough manner which only an organization with elaborate facilities can provide.

In this connection I wish to express the opinion that the new venture of publishing compendia of chemical literature, which the chemical societies of England and America are just now about to undertake, will prove of service to the progress of chemistry in English speaking countries, second only to that rendered by the journals of original and of abstract literature, which these societies have so successfully developed.

I realize, more than ever, that opportunities for the occurrence of errors are innumerable and although I have endeavored to maintain unremitting vigilance to avoid them, my efforts toward this end have not always been successful. I desire to express my appreciation to all who have called attention to errors in the former edition and I will be equally grateful to those who point out to me needed corrections in the present book. In this connection, I am greatly indebted to Professor B. N. Menshutkin of the Polytechnic Institute (Sosnovka), Petrograd, Russia, who, in calling my attention to an error in the tabulation of some of his work given in the first edition, sent me a complete set of reprints of his many papers on solubility and personally corrected the tables which I prepared from them, for use in the present volume.

In conclusion I wish gratefully to acknowledge the assistance rendered me by Dr. W. S. Putnam of the Cooper Union of New York during the compilation of the first 150 pages of the tables.

A. S.

WASHINGTON, D. C.,  
*Feb. 22, 1919.*



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The following detailed account of the collection and arrangement of the solubility data contained in the present volume, has been prepared particularly for those who need quantitative solubilities rarely, and are more or less unfamiliar with the usual tabular methods of expressing such data. To those who are better acquainted with the subject, the descriptions in some cases at least, will probably be considered more elementary than necessary. It is hoped, however, that with the aid of the explanations here given, no one need remain uncertain as to the true meaning of any result or form of expression found in the book.

*Sources of the Data.* — In addition to those determinations made for the specific purpose of ascertaining particular solubilities, many results are reported in connection with the study of theories of solution and are, therefore, easily located. On the other hand, since solubilities often form only an incidental part of an investigation, many valuable data can be found only by a very careful search of the literature. Consequently, in collecting material for the present compilation, the procedure was adopted of perusing, page by page, every volume of a selected number of chemical journals, for the years 1900 to 1918. In doing this, attention was paid particularly, to collecting all tabulated data, but a vigilant watch for solubility statements in the text was also maintained. The twenty-three journals which were examined in this manner are designated with asterisks (\*) in the volume-year table of journals given at the end of the book. There is also listed in this table a somewhat larger number of other journals, containing relatively few papers in which solubility data may be expected. In these cases, a page by page examination would have required more effort than the results to be gained appeared to justify. Consequently, only the tables of contents of these journals were searched for references to solubility data. The last volume number given for each journal in this table shows the final volume examined as above mentioned.

Of the abstract journals, only "Chemical Abstracts" was systematically searched for references to data published in other than the twenty-three journals which were minutely examined. The original of practically all references obtained in this way was consulted.



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The larger handbooks of inorganic and organic chemistry, such as those of Dammer, Moissan, Gmelin-Kraut, Abegg, Beilstein and others, were not examined, since it was believed that the major part of the data so obtained would undoubtedly have been already collected from the journals.

Of the available compendia of physical constants, only the fourth edition of Landolt and Börnstein's "Tabellen" and the three issues of the international "Tables annuelles de Constantes et Données Numérique" were systematically examined, and in these cases the volumes were used principally to check the completeness of the compilation made directly from the journals.

Of the various pharmacopœias and pharmaceutical reference books, only the eighth edition of the U. S. Pharmacopœia (1905) was used to any extent as a source of solubility data. Most of the results contained in the subsequent ninth edition (1916), are taken from the previous edition and calculated to the basis of volume, instead of weight, of solvent required to dissolve unit weight of solid. It is believed that, for the present compilation, the weight basis for expressing the results is to be preferred, and moreover, by taking the data directly from the eighth edition, the errors incidental to the recalculation and rounding off to whole numbers, are eliminated.

In this connection, it should be mentioned that the results obtained from pharmaceutical reference books for the more complex compounds such as the alkaloids, are for the most part of only qualitative interest, and although probably of sufficient exactness for use in pharmaceutical compounding, do not come within the scope of quantitative accuracy adopted for the present volume.

*Collection and Compilation of the Data.* — In all cases where solubility results were found recorded in an original communication, the data and accompanying descriptions of the experiments were copied and the record thus made filed for future use. In preparing these abstracts the actual experimental results were always recorded when available, rather than the values as recalculated by the author to terms which best suited the solution of the problem in hand. In many cases the original analytical data were not given and uncertainties arose as to the factors used and as to just how the calculations had been made. This was particularly true in the many cases where the results were expressed in gram molecular quantities per given volume of solution or on the basis of molecular percentage.

The supplementary information sought in each paper included such points as the method which had been employed for securing



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equilibrium, the care exercised in purifying the material, the exact composition of the solid phase, the procedure followed in separating the saturated solution and analyzing it, as well as any other details which might be of value in forming a correct estimate of the accuracy of the work. The time consumed in this part of the examination of the original papers was usually found to have been well spent when the compilation of the solubility tables from these data sheets was undertaken. This was especially the case when it became necessary to compare the results for the same compounds obtained by two or more investigators. When practically all abstracting of the solubility data in the journals already referred to had been completed, the data sheets, which were at first grouped according to the journals examined, were arranged alphabetically in accordance with the names of the compounds for which data had been determined. In this way all results for a particular compound were brought together and the actual preparation of the systematically arranged tables could be begun.

It will be noted that by this plan the original papers were practically all consulted before the actual compilation of any of the data was started. In only a small percentage of cases was the author's paper again consulted, at the time the manuscript of the compiled tables was prepared or later. Although this plan introduces numerous opportunities for errors resulting from the recopying of the original data, it appeared to be the only practical procedure. A more direct transference of the original results to the finished page would have required that the work be done in the library or that a much larger number of books be withdrawn than is ordinarily permitted.

Although it was originally intended to have the manuscript pages typewritten before transmitting them to the printer, this plan had to be abandoned on account of the difficulty in obtaining the services of a competent person and also on account of the considerable added expense. This necessity may possibly have resulted advantageously, since one of the several opportunities for the introduction of mistakes through copying the figures, was eliminated.

The copy as forwarded to the printer was, for the most part, clear and legible but it was far from the orderly character of typewritten pages, consequently, it would be surprising if none of the many errors made by the compositors as a result of imperfect copy, were overlooked during the proof-reading, which from beginning to end was done without assistance. In order to reduce



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typographical and all other errors to the least possible number, it would be necessary to compare every original paper with the final printer's proof and to repeat every calculation of a result one or more times. That this was not possible in the present case will be easily realized when the very large amount of the data is considered.

These details are mentioned at this time because it is believed that the user of the book is entitled to exact information in regard to the conditions under which the compilation was made. It is only with a clear understanding of its limitations that the book can be used to greatest advantage.

In this connection it should be pointed out that although opportunities for errors in recording the purely numerical data here brought together are abundant, in the majority of cases the mistakes are not necessarily misleading if proper regard is paid to the general import of the results as a whole. Thus on the basis of the well-established principle that changes in solubility, such as are due to temperature or concentration of solvent, always proceed regularly, errors in the case of one or more figures in a table will become apparent on careful comparison with the remaining results, or by plotting them on cross section paper and drawing the curve. Consequently, the table as a whole provides a check on the individual results of which it is composed.

*Scope.* — In brief, it may be stated that it has been the intention to include in this compilation the actual results, or a reference to all quantitative solubility data recorded in the journals referred to in a preceding section and listed in the table at the end of the book.

Freezing- or melting-points of binary or more complex systems, as explained in the footnote on page 1, are considered to be quantitative solubility data. The experimental results are quoted for only those systems in which one component is water or alcohol, or which are mixtures of fairly well-known compounds, and references are given to all others for which data were found.

Owing to the uncertainty of the boundary between solubility and other equilibria, it has been necessary arbitrarily to draw the line in regard to certain data which it has appeared wise to exclude. In accordance with this, no attempt has been made to gather either figures or references for the following:

1. Melting-point data for mixtures of metals, alloys.
2. Melting-point data for mixtures of minerals, except a few of relatively simple composition.



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- (c) Freezing-points of very dilute solutions made for the determination of molecular weights or electrolytic dissociation.
- (d) Data for the solubility of gases in molten metals.
- (e) The so-called solubility of metals in various solvents, due to a chemical reaction which occurs.
- (f) Data for solid solutions.
- (g) Data for compounds of unknown or variable composition.

*Order of Arrangement.*—The alphabetical arrangement is believed to have the advantage that data for particular compounds can be more easily located than would be the case if various compounds or systems had been grouped according to selected relationships. There is one difficulty which applies equally to any arrangement designed to avoid duplications, and that is the placing of those systems for which solubility results are given for two or more of the constituents involved. This applies especially to freezing-point lowering data for binary mixtures. In these cases the results show in turn the solubility of each component in the other and it is necessary to choose one, or to record the results under the name of each member in two separate places. There are many similar cases, in aqueous systems of two or more salts and of mixtures of liquids, where results are given in succession for the solubility of each component in solutions of varying concentrations of the other. In order to prevent duplication in these cases it was necessary arbitrarily to select that component under which the results for the entire system are to be recorded. In harmony with the general alphabetical plan of the book, it appeared most logical to make the selection on the basis of the alphabetical order of the names of the compounds involved. In the majority of cases, therefore, every system in which solubility data for two or more compounds are given, is placed under the name of that component, the initial of which comes earliest in the alphabet.

The advantage of this plan is that every system is assigned to a single position by rule and opportunities for unknowingly recording independent investigations of the same system, under different headings at widely separated portions of the book, are avoided.

An exception to this rule, which it was considered wise to observe, is in connection with mixed systems containing a compound of one of the rarer elements. In these cases, on account of the greater interest in the rare earth compound, the data have been located under its name.

In the case of those mixtures of salts and liquids which yield



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liquid layers over certain concentrations and, therefore, to all intents and purposes become reciprocally soluble liquid mixtures, they are placed under the name of the salt or of that component which exists as a solid under ordinary conditions. It has only rarely been possible to give cross references in the body of the book, but in all cases those components of the mixtures, other than the one under which the data are alphabetically recorded, are included in the subject index of the book and the reader, therefore, should not fail to consult the index when results or a cross reference to the desired compound are not found in the proper place in the body of the book.

*Nomenclature.* — In regard to questions of the proper naming of compounds for the purpose of their correct alphabetical arrangement, particularly in respect to organic compounds, the usage followed in the index of "Chemical Abstracts" has been adopted. Thus the name under which a given compound is indexed in "Chemical Abstracts" is, in practically all cases, the one used for deciding its position in the present compilation.

The most notable deviation from this rule is in the case of compounds of those metals to which specific names, differing from the name of the metal itself, have been given; thus, for example in the present compilation, iron salts are not classed under ferrous and ferric and tin salts under stannous and stannic but under iron and tin, respectively. Another exception is the grouping of di and tri substituted amines under the mono substituted compound, instead of placing them under the widely separated headings Di and Tri. Thus results for diethylamine and triethylamine are given in connection with ethyl amine instead of being grouped, on the one hand with dimethyl, dipropyl, diphenyl, etc., amines, and on the other with trimethyl, tripropyl, triphenyl, etc., amines.

In harmony with the adoption of "Chemical Abstracts" as authority for the correct naming of compounds, the rules adopted for that publication (see, in connection with index to Vol. II, 1917) have been followed as closely as possible in all other matters connected with systematic nomenclature. The exceptions which may be found are either mistakes, or occur in those tables reused from the first edition, in which corrections of the original plates would have cost more than the advantage to be gained appeared to justify. (For example, see first table, page 144, and many others in which the old forms of spelling names such as aniline, sulfate, glycerol, etc., have not been corrected.)

*Abbreviations.* — Although, in practically every case the abbre-



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viations which have been used are identical with those adopted for "Chemical Abstracts" and will, in general, be readily understood, for the sake of accuracy and as a matter of convenience a list of those made use of in the present volume is given at the close of this chapter. (Page xxi.)

*Literature References.*—In order to save space, when several references must be given in connection with one result or table, and to avoid the repetition of the complete journal reference when data for different compounds are given in the same paper, an abbreviated form of reference, consisting of the name of the author and year of the work, has been adopted. These are to be used in connection with the author's index, in which the complete references are arranged chronologically under each name. ㄱ

Deviations from this system occur in connection with the tables reused from the first edition. In these cases it was decided not to incur the expense of altering the plates simply for the sake of uniformity. The complete references given with the old tables are sometimes, but not always, repeated in the author's index.

*Forms of Stating and Methods of Calculating Solubilities to Desired Terms.*—When a solid compound is brought in contact with a liquid, more or less of it dissolves with the production of a homogeneous liquid mixture. The disappearance of the solid in the liquid continues, however, only up to a certain point, beyond which at a given temperature, no more of the solid can be made to dissolve. This quantity is designated as the solubility of the compound in the particular liquid. Solubility, therefore, always refers to a saturated solution and is expressed numerically in terms of the composition of the homogeneous liquid in equilibrium with an excess of undissolved solid. It is obvious that the composition of a saturated solution may be expressed in a great variety of terms and it is, therefore, to be expected that investigators will choose those terms which best suit the elucidation of the particular problems in hand.

As might be expected, the terms in most general use and those which permit of the widest applicability of the results, are based on the weights of the ingredients of the saturated solution. These may be either the weight of the dissolved compound contained in a unit weight (usually 100 grams) of the homogeneous liquid mixture, which corresponds to percentage of the dissolved compound in the saturated solution, or else the weight of the dissolved substance in a unit weight of the solvent. In either case the one form may be easily calculated to the other. Thus, for instance,



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if it is found that 100 grams of the saturated solution contain 20 grams of the dissolved compound, there can be present only  $100 - 20 = 80$  grams of solvent, and since this 80 grams of solvent holds 20 grams of the dissolved compound,  $20 \div 80 \times 100 = 25$  grams of it are present per 100 grams of solvent. The calculation in the opposite direction is, of course, just as simple. If 100 grams of solvent contain 25 grams of dissolved compound, then 100 + 25 grams of solution must contain 25 grams or 100 grams of saturated solution contain  $\frac{25}{1.25} \times 100 = 20$  grams of the dissolved compound.

In the case of most solubility statements contained in the pharmaceutical literature, the results are given in terms of weight or volume of solvent required to dissolve unit weight of solid. Since all such results are simply the reciprocal of the terms, grams solid contained in unit number of grams of solvent, the procedure for transforming them to the more usual form simply involves dividing 1 gram by the stated number of grams of solvent. In those cases, however, where the amount of solvent is expressed in volume instead of weight, it is first necessary to multiply by the specific gravity of the solvent in order to find the weight corresponding to the given volume.

A more serious complication is, however, introduced in those cases where the results have been reported only in terms of volume of the saturated solution (100 cc. or 1 liter). On account of the change in volume which always results when a solid dissolves in a liquid, a calculation of the weight of the solvent present, when only the weight of the dissolved compound and total volume of the solution is given, cannot be made. In these cases it is also necessary to know the weight of a unit volume of the saturated solution, that is, its specific gravity, in order to convert the results from the volume to the weight basis. Consequently, for solubility results to be most generally useful, the specific gravity of the saturated solution should always be determined.

The calculation of a given result from the volume to the weight basis or vice versa, with the aid of the specific gravity (density), is readily understood when it is remembered that this factor is simply the weight in grams of 1 cc. of the solution. If, for example, it is stated that 100 cc. of saturated solution contain 25 grams of salt and the specific gravity is 1.15, it is apparent that 115 grams of the solution contain 25 grams of the salt, or 100 grams contain  $\frac{25}{1.15} = 21.7$  grams. Conversely, when the calculation of the amount of salt in 100 cc. from that in 100 grams of solution is to



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be made, the weight of dissolved compound must be multiplied by the specific gravity.

One of the forms of presenting solubility data for which especial care is needed in converting the values to a different basis is in the case of results for salts with water of crystallization. In some instances these results are expressed in weight of the hydrated compound in a given volume or weight of the saturated solution. If it is desired to ascertain the weight of anhydrous salt present, it will be necessary first to calculate the grams of anhydrous salt equivalent to the stated number of grams of the hydrated compound and, if the results have been expressed in terms of volume of saturated solution, this will be all that is necessary, but if, for instance, the grams of hydrated salt per 100 grams of saturated solution or of water have been given, then it will be necessary to add the weight of water present as water of crystallization in the salt, to the weight of water present as solvent. The total weight of solvent is, therefore, made up of the weight of water used for preparing the solution and that carried by the salt as  $H_2O$  of crystallization.

In the case of solvents composed of mixtures of water and alcohol, or other liquids, authors sometimes fail to specify whether the figures for such mixtures refer to the weight or volume basis, consequently, without a specific gravity determination, the exact composition of the mixture is uncertain. The above remarks concerning the calculation of solubility results from one form to another apply equally to determinations made in mixed solvents, provided all supplementary data for accurately establishing the composition of the mixed solvent are given.

Although in most cases the actual experimental results of solubility determinations are obtained in terms of weight, many investigators find that certain advantages are to be gained, in particular problems, by converting their analytical results to the basis of normality or gram molecules, and in practically all such cases it is not thought necessary to present also the gram quantities from which the molecular values were calculated. Although this may be justified from the narrow point of view of the particular problem in hand, it is greatly to be deplored when the broader aspects of the value of solubility data as a whole are considered. As already mentioned, solubility results which have been determined for some one purpose may frequently be applied to the solution of other problems, or serve in the development or testing of generalizations or of laws of solution. It is, therefore, important that in the case of



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all solubility data the results should either be expressed in the gravimetric terms derived most directly from the experimental determinations, together with the specific gravities of, and solid phases in contact with the solutions, or else, when presented in terms more or less remote from those of the directly determined values, the method of making the calculations should be plainly indicated and all factors or supplementary data which have been used, presented in detail.

In preparing the present compilation occasion was several times taken to write to authors for data supplementary to those published, which although not essential to the solution of the particular problem in hand, and therefore omitted from the paper, were, nevertheless, needed for calculating the results to a form which would permit comparison with similar data by others or their use in the solution of other problems.

The calculation of results from the molecular basis to the gram basis or vice versa, introduces, in addition to the errors incidental to the calculation itself, those resulting from the selection of the atomic or molecular weights which are used as the factors. It is indeed rare for an author to state the actual molecular weights used for a calculation, and although the revisions of atomic weights which are occasionally made are usually not of great magnitude, opportunities for slight differences in recalculating results to a desired basis, due to differences in molecular weights, are worthy of consideration. A source of greater inaccuracies, however, is that resulting from the failure of authors to differentiate clearly between the significance of normality (gram equivalents) and gram molecules (formula weights) in calculating or in expressing their results.

It also occasionally happens that the compounds involved are described only by names which are not specific and a doubt may arise as to the exact formula expressing the composition of the compound in question. This applies particularly to work described in languages other than English. In cases of complex mixtures of several salts the results are sometimes given in terms of the ions present and the calculation of such results to the gram basis calls for especial care.

The general procedure for calculating gram quantities to the molecular basis consists simply in dividing by the molecular weight, or molecular equivalent weight in the case of results to be expressed in normality, and pointing off according to the unit quantity of solution selected. The reverse calculation is, of course, made by multiplying the molecular or normality values as given, by the



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molecular, or molecular equivalent weights. An example which will illustrate the principal points involved, is the case of the calculation of the grams of dissolved compound per 100 grams of solvent, from a result expressed in terms of molecular per cent, that is, in terms of molecules of dissolved compound present in a total of 100 molecules of dissolved compound plus solvent. Thus, in the case of the solubility of mercuric iodide in pyridine, it has been found that the saturated solution at 100° contains 25 mol. per cent  $\text{HgI}_2$ , which designates a mixture of 25 gram mols. of  $\text{HgI}_2$  and  $100 - 25 = 75$  gram mols. of pyridine. To convert to gram quantities, each figure is multiplied by the respective molecular weight and the product for the  $\text{HgI}_2$  divided by the product for the  $\text{C}_5\text{H}_5\text{N}$ . Thus,  $(25 \times 454.45) \div (75 \times 79.08) = 1.915$ , which,  $\times 100$ , = 191.5 grams  $\text{HgI}_2$  per 100 grams of  $\text{C}_5\text{H}_5\text{N}$ .

Although, in the present compilation an attempt has been made to calculate as many as possible of the data to terms of weight of the compounds involved, especially for the commoner substances, this has not appeared advisable in some cases, either on account of uncertainties as to the factors to be used, or on account of the relative unimportance of the data and the considerable labor which would have been involved in making the calculations.

The principal terms used in expressing the solubility of gases in liquids are defined in connection with the tables of data in the body of the book. See, for instance, p. 227.

*Explanation of Tables.* — Although the tables of results contained in the present volume will, it is hoped, be easily understood by all who are familiar with the subject, for the benefit of those who need solubility data only rarely, it has appeared desirable to mention some of the principles followed in constructing the tables and explain in detail the exact meaning of the results contained in a number of typical tables.

The main consideration in connection with a compilation such as the present one, is to arrange the very large amount of material in the most concise manner compatible with perfect clearness. It has, therefore, been necessary to adopt forms and abbreviations which eliminate the repetition of readily understandable details.

In general, it may be stated that the record of a solubility determination consists of the analytical results showing the composition of a homogeneous liquid mixture in equilibrium at a given temperature, with one or more solid compounds or with another homogeneous liquid mixture. In the case of aqueous solutions of salts, for instance, the analysis will show the weight of salt and of



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water contained in a given amount of the saturated solution. In recording this analysis, however, as solubility data, it is not customary to state the weight of water directly, since its quantity is derivable from the given weight of salt and of solution (salt plus water). Thus, in all cases the amount of the dissolved compound is numerically reported in terms of unit quantity (100 grams, one liter, etc.) of the saturated solution or of the solvent. The tables, therefore, all show in the heading above the columns of figures, the terms in which the results are expressed (grams, cubic centimeters, gram molecules, etc.) and the unit quantity of solution or solvent in which the numerically recorded amounts of dissolved compound are contained. When more than one column of figures are inclosed under a bracket below the heading, the arrangement is an abbreviation designed to eliminate the repetition of the heading over each column separately, and, therefore, indicates that the heading applies independently to each separate column of figures. Thus, in the case of the table showing the solubility of sodium nitrate in water (see p. 656) the heading which is as follows:

t°.	Gms. NaNO <sub>3</sub> per 100 Gms.		Mols. per Liter.
	Solution.	Water.	
0	42.2	72.9-73*	6.71*
10	44.7	80.8-80.5	7.16

when translated into its detailed meaning shows. (1) that at 0°, 100 grams of the saturated solution of sodium nitrate in water contain 42.2 grams NaNO<sub>3</sub>, (2) that at 0°, 100 grams of water dissolve from 72.9 to 73 grams NaNO<sub>3</sub> according to the authorities quoted (Mulder or Berkeley), and (3) that one liter of a saturated solution of sodium nitrate in water at 0° contains 6.71 gram molecules of NaNO<sub>3</sub>.

This general form of heading is typical and will be found in practically all cases where results for the solubility of a single salt in a single solvent at various temperatures are given. As will be noted, tables of this form show the results for a single series of determinations at increasing temperatures expressed in more than one set of terms. As a general rule, and especially when determinations of the specific gravities of the solutions are also given, any one of the figures for a given temperature may be calculated, as described in the previous section, from either of the others at the same temperature. The advantages of tables giving the results in several sets of terms are that the reader is relieved of making the calculations individually.



## GENERAL INFORMATION

In a number of cases where, either the importance of the compound does not warrant very detailed results, or where similar data for several near related compounds have been determined, composite tables showing the results for two or more compounds in one or more solvents have been constructed. Although by this procedure considerable space has been saved and frequent repetitions avoided, it is possible that clearness has sometimes been sacrificed.

An example of such a composite table is that for the three compounds,  $\text{CdI}_2 \cdot \text{KI} \cdot \text{H}_2\text{O}$ ,  $\text{CdI}_2 \cdot 2\text{KI} \cdot 2\text{H}_2\text{O}$  and  $\text{CdI}_2 \cdot 2\text{NaI} \cdot 6\text{H}_2\text{O}$  given in the first table on p. 178. The three solvents in which the solubilities were separately determined are placed in the first column of the table. Next follow the results for  $\text{CdI}_2 \cdot \text{KI} \cdot \text{H}_2\text{O}$ , given in terms both of grams of anhydrous salt,  $\text{CdI}_2 \cdot \text{KI}$ , per 100 grams of solution and per 100 grams of solvent. The next group of figures shows successively the solubility of  $\text{CdI}_2 \cdot 2\text{KI} \cdot 2\text{H}_2\text{O}$  in water, in absolute alcohol and in absolute ether, reported in each case, in terms of grams of anhydrous salt per 100 grams of saturated solution and also in grams per 100 grams of each solvent. The last group of figures, columns 6 and 7, gives similar results for  $\text{CdI}_2 \cdot 2\text{NaI} \cdot 6\text{H}_2\text{O}$ .

Other examples of this type of table are given on p. 188. In these cases results for three compounds, each in the same solvent but at different temperatures, are given. The abbreviation here adopted consists in providing only one column of temperatures to serve for each of the three sets of results given in the succeeding columns. This general plan is followed in a very large number of cases throughout the book.

One other example is that of the results for platinic double chlorides, given in the first table on p. 498. In this case, although each column of results represents an independent series of solubilities in water, they have all been grouped under the same bracket, instead of each being given under a separate, complete heading. By this plan a very compact arrangement has been provided but the results are apt to be misunderstood unless the reader bears in mind that here as elsewhere it has been necessary to condense the data as much as possible.

Before leaving the general subject of composite tables, attention should be called to one point which will be found illustrated in a large number of them. This is in reference to results at other temperatures than those which apply to the table as a whole, as recorded in the first column under the designation  $t^\circ$ . In these cases the figure for the temperature is given in a parenthesis immediately following the result for grams of compound dissolved and, of course,



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means that the particular determination was made at the temperature stated in the parenthesis, instead of at the temperature shown in the column  $t^{\circ}$ , which applies to all the results not so modified.

This principle of indicating in parentheses any variations from the general order of the table, and also in respect to the introduction of additional matter, such as results for densities, points on the character of the solutions, etc., is one which has been followed in many instances.

As already stated, a solubility is an expression of the concentration of a solution in equilibrium with a particular solid compound. Therefore, if a compound can exist in more than one form at a given temperature, such as in different states of hydration, its solubility will show variations in accordance with which one of its forms is in contact with the saturated solution at the particular temperature. Information in regard to the solid phase is, consequently, essential to the accurate expression of a solubility. Whenever such facts are available they are shown in the tables by means of formulas recorded under the heading "Solid Phase." These formulas are usually placed on a line with the numerical results for the solution in contact with the solid represented by the formula given.

A case which illustrates strikingly the multiplicity of variations in solubility with change in degree of hydration is that of the solubility of the hydrates of ferric chloride in water (see p. 337). In this case, to economize space, the formula for the hydrate has been placed immediately above that group of data to which each refers, instead of on the same line with the results for each solution in contact with that particular hydrate. An examination of this table will show the apparent anomaly that the same hydrate possesses two different solubilities at certain temperatures. Thus, in the section of the table giving results for solutions in contact with the solid phase  $\text{Fe}_2\text{Cl}_6 \cdot 12\text{H}_2\text{O}$ , it will be noted that 100 grams of  $\text{H}_2\text{O}$  dissolve 106.8 grams  $\text{FeCl}_3$  at  $30^{\circ}$  and two lines below, the same amount of water is stated to dissolve 201.7 grams  $\text{FeCl}_3$  at  $30^{\circ}$ . This is due to the fact that each of the hydrates gives a more or less well developed reverse solubility curve. The character of these curves is plainly indicated by plotting them on cross-section paper from the results given in the table. If this is done it will be seen that in case of the results for  $\text{Fe}_2\text{Cl}_6 \cdot 12\text{H}_2\text{O}$ , the grams of  $\text{FeCl}_3$  contained in 100 grams of water increase regularly with rise of temperature up to  $37^{\circ}$ , which is the melting-point of this hydrate. If



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more crystals are added and the temperature raised above  $37^{\circ}$ , they melt and form a homogeneous solution of increased concentration. If, however, this more concentrated solution is cooled again below  $37^{\circ}$ , and crystals then added, they remain as solid phase and, when equilibrium is established, the composition of the solution corresponds to a point on the upper, reverse arm, of the solubility curve. With this salt, therefore, it is seen that for certain ranges of temperature the concentration of the saturated solution depends upon the procedure by which the point of equilibrium has been approached.

In cases where results are given for the solubility of a particular compound in aqueous solutions of another, the heading above the columns of figures shows, as usual, the terms in which the results are expressed (gms., cc., mols., etc.) and the unit amount of solution or solvent in which the recorded amounts of each compound is contained; while below the bracket are given, at the heads of the columns, the formulas of the respective compounds simultaneously present in the solution. Thus, there will usually be found in one column, the increasing concentrations of the salt present in the aqueous solution constituting the solvent, and in the other the amounts of the other compound of which the solubility is being determined and which is present as solid phase in contact with the solution. Examples of this form of table are those for the solubility of calcium sulfate in aqueous salt solutions (pp. 215 to 219) and numerous others throughout the book. In all cases where the solid phase exists in more than one form, this information, when available, is recorded in the usual manner in the column under the heading "Solid Phase." (See pp. 174, 185, 203, 404, and many others.) The results for the specific gravities of the saturated solutions are also given, when available. It is needless to say that, according to the arrangement of these tables, the figures in the horizontal lines refer to the same solution and those in the vertical columns to different solutions of the series.

In the case of tables showing the distribution of a compound between two immiscible solvents (see for example, results for mercuric chloride, pp. 420 and 421), the amounts of the dissolved compound in the conjugate layers are given under the same bracket with column headings designating the respective layers. In the case of equilibria in ternary systems, which form two liquid layers (see for example, last table, p. 511), the compositions of the upper and lower layers are given under separate brackets, the results on each horizontal line being for layers in contact with each other.



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Data of this character are described more fully in the chapter on Methods for the Determination of Solubility.

The types of cases which have just been described were pointed out by users of the first edition of the book who did not understand the arrangement in these cases and suggested that an explicit description of them would make the book more generally useful. It is realized that the explanations which have been given here apply only to a certain proportion of the tables in the book. There are, no doubt, many tables and forms of expression, especially for the more complex systems, which will not be understood by the casual reader. In some of these cases brief remarks in connection with the tables have been given, but to just what extent these explanatory remarks are warranted, it has been difficult to decide. In conclusion, it should be mentioned that the title of the table is intended to describe the nature of the results and should always be used as a guide in the interpretation of the tabular arrangement.



## ABBREVIATIONS

Most of the following abbreviations will be found written both with capitals and without.

- |   |   |
|---|---|
| [ $\alpha$ ] <sub>D</sub> — Specific Rotation.  | g., gm., gms. — Gram(s).  |
| abs. — Absolute.  | gm. mol. — Gram Molecule(s).  |
| abs. coef. — Absorption Coefficient.  | G. M. — Gram Molecule(s).   |
| alcohol. — Ethyl Alcohol.   | hr(s). — Hour(s).   |
| amt(s). — Amount(s).  | <i>i.</i> — ( <i>d</i> + <i>l</i> ) Inactive (in connection with the name of an optically active compound.) |
| anhy. — Anhydrous.  | inorg. — Inorganic.   |
| aq. — Aqueous.  | insol. — Insoluble.   |
| atm(s). — Atmosphere(s).  | <i>l.</i> — Lævo (in connection with the name of an optically active compound).                             |
| at. wt. — Atomic Weight.  | kg. kgm. — Kilogram(s).   |
| b.-pt. — Boiling-point.   | l. — Liter(s).  |
| C. — Centigrade.  | mm. — Millimeter(s)   |
| calc. — Calculate(ed).  | <i>m.</i> — Meta.   |
| cc. — Cubic Centimeter(s).  | max. — Maximum.   |
| cm. — Centimeter(s).  | mg., mgm. — Milligram(s).   |
| coef. — Coefficient.  | mol(s). — Molecule(s), Molecular.   |
| com. — Commercial.  | mol. wt. — Molecular Weight.  |
| compd. — Compound.  | millimol. — Milligram Molecule.   |
| conc. — Concentration, Concentrated.  | m.-pt. — Melting-point.   |
| cond. — Conductivity.   | <i>n.</i> — Normal (gm. equiv. per l.).   |
| const. — Constant.  | N. — Normal (used rarely).  |
| cor. — Corrected.   | <i>o.</i> — Ortho.  |
| crit. — Critical.   | ord. — Ordinary.  |
| cryo. — Cryohydric.   | org. — Organic.   |
| cryst. — Crystalline.   | p. — Page.  |
| <i>d.</i> — Dextro (in connection with the name of an optically active compound).   | <i>p.</i> — Para.   |
| <i>d.</i> — Density ( <i>d</i> <sub>18</sub> — Specific Gravity at 18°, referred to water at 4°; <i>d</i> <sub>20</sub> at 20° referred to water at 20°). | pet. — Petroleum.   |
| decomp. — Decomposition.  | ppt. — Precipitate.   |
| diff. — Different.  | pt. — Point.  |
| dil. — Dilute.  | quad. pt. — Quadruple Point.  |
| dist. coef. — Distribution Coefficient.   | qual. — Qualitative.  |
| ed. — Edition.  | sapon. — Saponification.  |
| elec. — Electric(al).   | sat. — Saturated.   |
| equil. — Equilibrium.   | sol(s). — Solution(s).  |
| equiv. — Equivalent(s).   | sp. gr. — Specific Gravity (Density).   |
| eutec. — Eutectic.  | sq. cm. — Square Centimeter.  |
| F. — Fahrenheit.  | <i>s.</i> — Symmetrical.  |
| f.-pt. — Freezing-point.  | sym. — Symmetrical.   |



## ABBREVIATIONS

t°. — Temperature, Centigrade Scale.

temp(s). — Temperature(s).

tr. pt. — Transition Point.

vol(s). — Volume(s).

undissoc. — Undissociated.

U. S. P. — U. S. Pharmacopœia.

wt. — Weight.

∞ — Infinity.

$.10^{-2}$ ,  $.10^{-3}$ , etc., following a result means that the decimal point is to be moved as many places to the left as indicated by the minus exponent.



## ERRATA

### IN THE SECOND EDITION OF "SOLUBILITIES OF INORGANIC AND ORGANIC COMPOUNDS," 1919

Page 1.—It is erroneously stated in the Note under Acenaphthene that the original results of Speyers are in terms of gram molecules of solute per 100 gram molecules of *solvent*. This should have been gram molecules of solute per 100 gram molecules of *solution*. Due to this error all the calculations to the gram basis given in the tables of results by Speyers are incorrect. The tables in which such erroneous results occur are:

Page 1,	Acenaphthene.
Page 3,	Acetanilide.
Page 124,	Benzamide.
Page 244,	Chloral Hydrate.
Page 444-6,	Naphthalene.
Page 478,	Phenanthrene.
Page 580,	Resorcinol.
Page 693,	Succinimide.
Page 731,	Toluidine.
Page 737,	Urea.
Page 741,	Urethan.

The recalculated values for each of the above compounds are given in the Supplement to the Second Edition of "Solubilities," 1928.

Page 39, 4th line.—Change Ammonium Arsenate to Ammonium Arsenite.

Page 70, 19th line.—Change Renolds to Reynolds.

Page 73, 1st line.—Change the heading Solubility of Amylene in Liquid Carbon Dioxide to Critical Temperatures of Vaporization of Mixtures of Amylene and Liquid Carbon Dioxide.

In the last table on this page change the heading of the 3d and 6th columns to Gms. H<sub>2</sub>O per 100 gms. Aniline Layer.

Page 81, 20th line.—The reference. See Note, p. 447 should be See Note p. 477.

Page 82, 44th line.—The reference. See Note, p. 447 should be See Note p. 477.



Page 102.—In the last table on this page the results under  $t^{\circ}$  are critical solution temperatures, and the table does not correctly interpret the author's results.

Page 117.—First table. The results of Masson are incorrectly given. The corrected values will be found on page 1081 of the Supplement to the Second Edition of "Solubilities."

Page 126, 14th and 23d line.—Change Ennis to Ewins.

Page 131.—The reference (line 13) following the first tables should be changed to read "Data for the mutual solubility of nitrobenzene in hexane, decane and American petroleum in the liquid state at pressures up to 3000 atmospheres are given by Kohnstamm and Timmermans (1913)."

Page 135, 3d line from bottom page.—Change 7.76 to 7.6.

Page 135, 2d line from bottom of page.—Change  $23^{\circ}$  to  $18^{\circ}$ .

Page 146.—The table of results for Benzophenone quoted from Timmermans does not correctly interpret the author's experiments.

Page 180.—Last table on page, change heading of last column from Gram Mols. Salt per 100 cc.  $H_2O$  to Gram Mols.  $CsM'''(SO_4)_2 \cdot 12H_2O$  per 100 cc.  $H_2O$ .

Page 228.—Last table on page, in the first line of results change 1.84 to 1.46 and 4.35 to 1.37.

Page 261, 1st line.—The formula for cocaine should be changed to  $C_{17}H_{21}NO_4$ .

Page 276, 2d table, 2d column.—Change 19.6 to 15.6 and in 5th column 15.65 to 12.45.

Page 279, last table.—Change Pratolongo 1913 to Pratolongo 1914.

Page 307.—In the table showing the results of Pfeiffer and Würgler upon Glycine change, in the 3d column, 2.954 to 2.454, 4.848 to 2.424 and 4.994 to 2.497. In the last column change 4.188 to 2.094 and 4.245 to 2.122.

Page 326, second table, last column.—Change 4.68 to 14.68.

Page 329, first table.—The calculations of the results of McLauchlan given in this table are based upon the value 0.034 gm. I. per 100 cc. instead of his original figure which was considered too low.

Page 440, 2d line.—Add the reference (Dubroca, 1907).

Page 468.—In the table showing the solubility of Oxalic acid in aqueous  $HNO_3$  the solid phase in contact with the solutions of higher concentration than 15.0 gm. mols  $HNO_3$  per liter is anhydrous oxalic acid.



Page 493, first table.—The figures in the 3d column under  $\text{NaNO}_3$  (except the first) were copied from an error in the original paper and are consequently incorrect.

Page 495.—The results of Rothmund and Drucker (*Z. physik. Chem.* 46, 833, 1903) should be added to those of Kuriloff given in the second table of this page.

In the table showing the solubility of Methyl Picric Acid, the aq. solvent water + toluene should be changed to water + benzene.

Page 518, second table.—The heading of the second column should be changed from KOH to  $\text{K}_2\text{O}$ . This necessitates the recalculation of the figures given in the 5th column. Those given in the 4th column are also subject to a slight correction.

Page 525.—Following the second table on this page a note should be added stating that no solid phase could be present when equilibrium is attained since with vapor there are 3 components and 4 phases; hence if the temperature is fixed the system becomes invariant.

Page 593, last line.—Change Malvino to Levi-Malvano and Manino to Mannino.

Page 617, last table.—The temp.  $25^\circ$  should be changed to  $30^\circ$ .

Page 642, second table.—The bracket headings for the second, third and fourth pair of columns should be changed respectively to Gms. per 100 cc., Mols per 1000 gms.  $\text{H}_2\text{O}$  and Gms. per 100 gms.  $\text{H}_2\text{O}$ .

Page 644, first table, 4th column.—Change 183.2 to 83.2.

Page 675, 35th line.—Change Bautarie to Boutaric.

Page 695, 1st table, column 6.—Change 46.28 to 49.28 and in column 7 29.57 to 29.42.

Page 710, 1st table.—Change the heading of column 3 from  $\text{TaH}_3$  to  $\text{TaF}$  and eliminate 1 from the formulas  $\text{HF1}$  and  $\text{KF1}$  in the preceding paragraph.

Page 729, 8th line from bottom.—Change Capisarow to Copisarow.

Page 794.—Change Ennis to Ewins.

Page 797.—Add Hartley, H. and Stewart (1914) *J. Chem. Soc. Lond.* 105, 309.

Page 803.—Add Kruyt, H. R. and Heldermaun (1918), *Z. physik. Ch.* 93, 89.

Page 805.—The name Malvano should be changed to Levi-Malvano and moved to p. 804.



Page 817.—Add Steger (1903) *Z. physik. Ch.* 43, 595.

Page 817.—Add Sudborough, J. J. and Beard (1910) *J. Ch Soc.* 97, 771.

Page 817.—Change the reference under the name of Stoltberg from *Z. physik. Ch.* to *Z. physiol. Chem.*



ACENAPHTHENE  $C_{12}H_{10}$ .

## SOLUBILITY IN SEVERAL ORGANIC SOLVENTS.

(Speyers — Am. J. Sci. [4] 14, 294, 1902.)

NOTE. — In the original paper the results are given in terms of gram molecules of acenaphthene, acetamide, acetanilide, etc., per 100 gram molecules of solvent, at temperatures which varied with each solvent and with each weighing of the solutions. The tabulated results here given were obtained by recalculating and reading the figures from curves plotted on cross-section paper.

t°.	In Methyl Alcohol.			In Ethyl Alcohol.			In Propyl Alcohol.		
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
0	81.33	1.80	0.39	81.1	1.9	0.57	82.3	2.26	0.88
10	80.40	1.70	0.38	80.3	2.8	0.84	81.8	2.40	1.00
20	79.60	2.25	0.48	79.6	4.0	1.20	81.4	3.40	1.35
30	79.00	3.50	0.72	79.1	5.6	1.70	80.9	4.75	1.90
40	78.45	6.00	1.20	78.7	8.4	2.60	80.6	7.10	2.90
50	78.15	9.00	1.77	78.8	13.2	3.90	80.7	11.10	4.40
60	78.30	11.70	2.35	79.4	23.2	7.00	81.5	19.60	8.20
70	78.60	14.30	2.90	80.75	40.5	12.50	83.9	37.00	16.20

t°.	In Chloroform.			In Toluene.		
	(a)	(b)	(c)	(a)	(b)	(c)
0	143.8	16.4	12.7	90.7	13.18	7.9
10	140.1	20.6	16.0	90.8	18.0	10.7
20	136.3	27.0	19.5	91.0	24.5	14.5
30	132.4	34.0	25.0	91.8	33.5	20.5
40	128.0	42.5	32.0	92.7	47.0	28.0
50	123.4	51.5	40.0	94.0	60.5	35.7
60	119.3	62.5	50.0	95.5	74.0	43.5
70	...	...	...	97.2	89.0	52.5

(a) Weight of 100 cc. solution in grams. (b) Grams dissolved substance per 100 grams solvent.

(c) Gram molecules of dissolved substance per 100 gram molecules of solvent.

1000 gms. Aq. 25%  $NH_3$  dissolve 0.07 gm. acenaphthene at 25°. (Hilpert, 1916).

RECIPROCAL SOLUBILITIES DETERMINED BY THE METHOD OF LOWERING OF THE FREEZING-POINT\* ARE GIVEN BY GIUA (1915), FOR THE FOLLOWING PAIRS OF COMPOUNDS:

Acenaphthene + *m* Dinitrobenzene.  
 " + 2,4 Dinitrotoluene.  
 " +  $\alpha$  Trinitrotoluene.

\* *Freezing or Melting-point Curves as Solubility Data.* — When a mixture of two compounds, rendered liquid by elevation of temperature, is gradually cooled, a point will be reached at which one or the other of the constituents will separate as a solid. This point represents the solubility of the one compound in the other. The method involved, differs principally from that ordinarily employed for solubility determinations, in that the composition of the mixture remains constant while the saturation temperature is being approached, instead of the reverse procedure.

A considerable amount of data of this character is available, but, after careful consideration, it has been decided that references only will be given to it in the present volume, except in cases of mixtures of well-known compounds or of those in which water is one of the constituents.



# ACENAPHTHENE

2

RECIPROCAL SOLUBILITIES (Freezing-point Lowering Data, see footnote, page 1)  
ARE GIVEN FOR THE FOLLOWING PAIRS OF COMPOUNDS:

Acenaphthene + Chloroacenaphthene	(Crompton and Walker, 1912.)
" + Bromoacenaphthene	" "
" + Iodoacenaphthene	" "
" + Benzil	(Pawlewski, 1893.)
" + <i>p</i> Nitrobenzoic Aldehyde	(Fazi, 1916.)
" + Piperonic Aldehyde	"
" + Vanillic Aldehyde	"
Chloroacenaphthene + Bromoacenaphthene	(Crompton and Walker, 1912.)
" + Iodoacenaphthene	" "
Bromoacenaphthene + " "	" "

# ACETALDEHYDE CH<sub>3</sub>COH.

SOLUBILITY IN ETHYL ALCOHOL DETERMINED BY THE METHOD OF LOWERING  
OF FREEZING-POINT (de Leeuw, 1911). Liquid air was used as the cooling  
medium and temperatures were measured with the aid of a specially con-  
structed resistance thermometer.

t°.	Wt. Per Cent CH <sub>3</sub> COH in Mixture.	Mol. Per Cent CH <sub>3</sub> COH in Mixture.	Solid Phase.	t°.	Wt. Per Cent CH <sub>3</sub> COH in Mixture.	Mol. Per Cent CH <sub>3</sub> COH in Mixture.	Solid Phase.
-123.3	100	100	CH <sub>3</sub> COH	-122.3	51.8	50.7	CH <sub>3</sub> COH.C <sub>2</sub> H <sub>5</sub> OH
-125.4	90.7	90.3	"	-125.3	45.6	44.5	"
-127.6	84.5	83.9	"	-128	40.6	39.5	CH <sub>3</sub> COH.2C <sub>2</sub> H <sub>5</sub> OH
-132	80.9	80.2	(Eutectic)	-123.2	35.3	34.3	"
-126	78.1	77.3	CH <sub>3</sub> COH.C <sub>2</sub> H <sub>5</sub> OH	-126.8	30.2	29.3	"
-126	75.2	74.4	"	-130.6	17.9	17.3	C <sub>2</sub> H <sub>5</sub> OH
-124.3	67.0	66.0	"	-120.6	10.2	9.8	"
-123.5	60.8	59.7	"	-114.9	0.0	0.0	"

Freezing-point data for mixtures of acetaldehyde and paraldehyde as well  
as the complete  $x - T$  diagrams are given by Holleman (1903). Results for  
mixtures of paraldehyde and *p* xylene are given by Paterno and Ampola (1897).

Results for mixtures of the  $\alpha$  and  $\beta$  forms of Acetaldehyde phenyl hydrazone  
are given by Laws and Sidgwick (1911).

# ACETAMIDE CH<sub>3</sub>CO.NH<sub>2</sub>.

## SOLUBILITY IN WATER AND IN ALCOHOL.

(Speyers.)

t°.	In Water.			In Ethyl Alcohol.		
	(a)	(b)	(c)	(a)	(b)	(c)
0	105.5	70.8	29.6	85.62	17.3	18.5
10	104.9	81.0	34.0	86.2	24.0	26.0
20	104.3	97.5	40.8	87.3	31.5	33.8
30	103.7	114.0	47.7	88.8	40.5	43.0
40	103.0	133.0	55.5	90.7	50.0	53.5
50	102.3	154.0	64.0	93.0	61.0	64.5
60	101.6	177.5	74.0	95.5	72.0	76.5

(a) Wt. of 100 cc. sat. solution in gms. (b) Gms. Acetamide per 100 gms. solvent. (c) Gm. mols.  
Acetamide per 100 gm. mols. solvent.

100 gms. pyridine dissolve 17.75 gms. acetamide at 20-25°; 100 gms. aq. 50 per  
cent pyridine dissolve 84.7 gms. acetamide at 20-25°. (Dehn, 1917.)

Freezing-point curves are given for: Acetamide + Benzene (Moles and  
Jimeno, 1913); Acetamide + Phthalide (Lautz, 1913); Acetamide + Triphenyl  
guanidine (Lautz, 1913); Tribromoacetamide + Trichloroacetamide (Küster,  
1891).



**ACETANILIDE**  $C_6H_5NH.COCH_3$ .

## SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Sp. Gr. of Sat. Solution.	Gms. $C_6H_5NH.COCH_3$ per 100 Gms. Sat. Solution.	Authority.
Water	16	...	0.47	(Greenish and Smith, 1903.)
"	25	0.997	0.54	(Holleman and Antush, 1894.)
"	30	1.000	0.69	(Seidell, 1907.)
Ether	25	...	2.8	(Marden and Dover, 1916.)
Formic Acid (95%)	16.8	1.121	56.74	(Aschan, 1913.)
Acetic Acid (99.5%)	21.5	...	33.21	(Seidell, 1907.)
Acetone	30-31	0.902	31.15	"
Amyl Acetate	"	0.882	10.46	"
Amyl Alcohol	25	...	14.00	"
Aniline	30-31	1.034	19.38	"
Benzene	"	0.875	2.46	"
Benzaldehyde	"	1.068	18.83	"
Toluene	25	0.862	0.50	"
Xylene	32.5	0.847	1.65	"
Pyridine	20-25	...	32.7	(Dehn, 1917.)
50% Aq. Pyridine	"	...	35.7	"
Petroleum Ether	about 20	...	0.03	(Salkower, 1916.)

SOLUBILITY IN METHYL ALCOHOL, ETHYL ALCOHOL AND IN CHLOROPFORM.  
(Speyers, 1902.) See Note, page 1.

t°.	In $CH_3OH$ .		In $C_2H_5OH$ .		In $CHCl_3$ .	
	Sp. Gr. of Sat. Solution.	Gms. $C_6H_5NH.COCH_3$ per 100 Gms. Sat. Solution.	Sp. Gr. of Sat. Solution.	Gms. $C_6H_5NH.COCH_3$ per 100 Gms. Sat. Solution.	Sp. Gr. of Sat. Solution.	Gms. $C_6H_5NH.COCH_3$ per 100 Gms. Sat. Solution.
0	0.860	18.5	0.842	12.8	1.503	3.53
10	0.864	23.1	0.844	16.7	1.475	7.24
20	0.875	29.1	0.850	21.3	1.440	10.7
30	0.892	35.1	0.860	26.5	1.398	14.5
40	0.911	42.9	0.874	32.9	1.354	18.7
50	0.932	51.7	0.895	39.4	1.314	23.7
60	0.957	59.2	0.920	46.4	1.272	29.1

## SOLUBILITY OF ACETANILIDE IN MIXTURES OF ETHYL ALCOHOL AND WATER.

Wt. Per Cent $C_2H_5OH$ in solvent.	Results at 25°. (Holleman and Antush, 1894.)		Results at 30°. (Seidell, 1907.)	
	Sp. Gr. of Sat. Solution.	Gms. $C_6H_5NH.COCH_3$ per 100 Gms. Sat. Solution.	Sp. Gr. of Sat. Solution.	Gms. $C_6H_5NH.COCH_3$ per 100 Gms. Sat. Solution.
0	0.997	0.54	1.000	0.69
10	0.985	0.93	0.984	1.00
20	0.973	1.28	0.970	2.20
30	0.962	2.30	0.956	4.80
40	0.950	4.85	0.945	9.40
50	0.939	8.87	0.934	15.40
60	0.928	14.17	0.926	22.00
70	0.918	19.84	0.917	27.60
80	0.907	25.17	0.907	31.20
85	0.899	26.93	0.900	31.70
90	0.890	27.65	0.893	31.60
95	0.874	26.82	0.885	30.80
100	0.851	24.77	0.876	29.00

(See remarks under  $\alpha$  Acetnaphthalide, page 13.)



# ACETANILIDE

4

## SOLUBILITY OF ACETANILIDE IN MIXTURES OF ETHER AND CHLOROFORM AND OF ACETONE AND BENZENE AT 25°. (Marden and Dover, 1916.)

Results for Ether-Chloroform Mixtures.		Results for Acetone-Benzene Mixture.	
Wt. Per Cent $\text{CHCl}_3$ in Mixed Solvent.	Gms. $\text{C}_6\text{H}_5\text{NH.COCH}_3$ per 100 Gms. Mixed Solvent.	Wt. Per Cent $\text{C}_6\text{H}_6$ in Mixed Solvent.	Gms. $\text{C}_6\text{H}_5\text{NH.COCH}_3$ per 100 Gms. Mixed Solvent.
100	17.7	100	1.36
90	11.7	90	6.78
80	8.2	80	13.0
70	6.2	70	20.0
60	4.95	60	29.2
50	4.25	50	30.0
40	3.8	40	30.5
30	3.5	30	33.0
20	3.25	20	36.0
10	3.05	10	45.7
0	2.9	0	39.4

### DISTRIBUTION OF ACETANILIDE BETWEEN IMMISCIBLE SOLVENTS AT 25°.

Conc. $\text{C}_6\text{H}_5\text{NH.COCH}_3$ in Benzene	layer +	Conc. in $\text{H}_2\text{O}$ layer = 1.65.	(Farmer and Warth, 1904.)
"	"	" Chloroform " +	Conc. in $\text{H}_2\text{O}$ layer = 7.75.
"	"	" Ether " +	Conc. in $\text{H}_2\text{O}$ layer = 2.98.
			(Marden, 1914.)

## SOLUBILITY OF HALOGEN SUBSTITUTED ACETANILIDES IN ETHYL ALCOHOL AT DIFFERENT TEMPERATURES. (Chattaway and Lambert, 1915.)

Gms. of Each Anilide per 100 Gms. of Each Sat. Solution.

t°.	<i>p</i> Chloroacetanilide.	2,4 Dichloroacetanilide.	<i>p</i> Bromoacetanilide.	2,4 Dibromoacetanilide.	4 Chloro-2 Bromoacetanilide.	2 Chloro-4 Bromoacetanilide.
5	.....	.....	4.244	2.480	...	...
10	3.278	3.008	4.847	2.876	4.334	2.575
15	3.777	3.564	5.561	3.382	5.088	2.961
20	4.366	4.192	6.390	4.002	5.986	3.466
25	5.040	4.962	7.300	4.714	7.043	4.095
30	5.828	5.864	8.440	5.615	8.328	4.891
35	6.700	6.937	9.715	6.686	9.844	5.820
40	7.728	8.276	11.156	7.914	11.586	6.887
45	8.918	9.750	12.767	9.357	13.718	8.186

(Results for unstable needle forms of *p* bromoacetanilide and 2,4 dibromoacetanilide are also given.)

## SOLUBILITY OF *p* NITROACETANILIDE AND OF 2,4 DICHLOROACETANILIDE IN ACETIC ACID AT 16°. (Orton and King, 1911.)

Compound.	Solvent.	Gms. Compd. Dissolved per 100 cc. Sat. Sol.
<i>p</i> Nitroacetanilide	Glacial Acetic Acid	0.83
"	50% Aq. " "	0.38
2,4 Dichloroacetanilide	Glacial Acetic Acid	6.37
"	50% Aq. " "	0.83

Freezing-point curves (see footnote, page 1) are given for mixtures of:

Acetanilide and Antipyrine	(Comanducci, 1912.)
" " <i>m</i> Nitraniline	(Crompton and Whiteley, 1895.)
" " <i>m</i> Dinitrobenzene	" "
" " $\alpha$ Dinitrophenol	" "
" " <i>p</i> Nitroacetanilide	(Kuster, 1891.)
<i>p</i> Nitroacetanilide and Dinitroacetanilide	(Holleman and Sluiter, 1906.)
<i>p</i> Bromoacetanilide and 2,4 Dibromoacetanilide	(Sidgwick, 1915.)



ACETIC ACID  $\text{CH}_3\text{COOH}$ .

RECIPROCAL SOLUBILITY OF ACETIC ACID AND WATER DETERMINED BY THE METHOD OF LOWERING OF THE FREEZING-POINT.

t°.	Gms. $\text{CH}_3\text{COOH}$ per 100 Gms. Sat. Solution.	Solid Phase.	t°.	Gms. $\text{CH}_3\text{COOH}$ per 100 Gms. Sat. Solution.	Solid Phase.
0	0	Ice	-20	67.0	$\text{CH}_3\text{COOH}$
-5	15.2	"	-15	72.3	"
-10	28.5	"	-10	77.5	"
-15	40.0	"	-5	82.2	"
-20	49.2	"	0	87.0	"
-25	57.0	"	+5	91.8	"
-26.7	60.0	(Eutectic)	10	95.8	"
-25	62.5	$\text{CH}_3\text{COOH}$	16.6	100.0	"

The data in the above table were obtained by plotting the results of Pickering (1893), Roloff (1895), Dahms (1896) (1899), de Coppet (1899), Kremann (1907), Faucon (1910), Balló (1910), Groschuff (1911), Paterno and Salimei (1913), and Tsakalotos (1914), on cross-section paper and drawing a curve through the points in best agreement. In addition to making determinations of the freezing-points of the mixtures, Balló also analyzed the solid phases which separated, and showed that these contained, in all cases, increasing percentages of acid and, therefore, must have consisted of mixed crystals. This formation of mixed crystals is offered as an explanation of the abnormality of the freezing-point lowering of the system.

SOLUBILITY OF ACETIC ACID IN ETHYL ALCOHOL (98.9%) DETERMINED BY THE METHOD OF LOWERING OF FREEZING-POINT. (Pickering, 1893.)

t°.	Gms. $\text{CH}_3\text{COOH}$ per 100 Gms. Sat. Solution.	Solid Phase.	t°.	Gms. $\text{CH}_3\text{COOH}$ per 100 Gms. Sat. Solution.	Solid Phase.
-75	26.0	$\text{CH}_3\text{COOH}$	-10	67.7	$\text{CH}_3\text{COOH}$
-70	27.7	"	-5	73.2	"
-60	33.0	"	0	79.1	"
-50	38.2	"	+5	85.2	"
-40	43.7	"	10	91.5	"
-30	50.2	"	15	98.0	"
-20	58.0	"	16.6	100.0	"

(The original results were plotted on cross-section paper and the above figures read from the curve.)

SOLUBILITY DATA DETERMINED BY THE METHOD OF LOWERING OF THE FREEZING-POINT (see footnote, page 1) ARE GIVEN FOR MIXTURES OF Acetic Acid AND EACH OF THE FOLLOWING COMPOUNDS:

Chloroacetic Acid (Mameli and Mannesier, 1913; Kendall, 1914.)	Dimethylpyrone (Kendall, 1914 (a).)
Dichloroacetic Acid (Kendall, 1914.)	Dimethyl Oxalate (Kendall and Booge, 1916.)
Trichloroacetic Acid (Kendall, 1914.)	Dimethyl Succinate (Kendall and Booge, 1916.)
Acetic Anhydride (Pickering, 1893.)	Ethyl Ether (Pickering, 1893.)
Benzene (Dahms, 1895, 1896; Roloff, 1895; Groschuff, 1911; Baud, 1912, 1912 (a); Kendall and Booge, 1916.)	Ethylene Bromide (Dahms, 1895; Baud, 1912 (a).)
Benzene + Vaseline (Roloff, 1895.)	Ethylene Dibromide (Baud, 1912 (b).)
Benzene + Naphthalene (Roloff, 1895.)	Formamide (English and Turner, 1915.)
Benzene + Water (Roloff, 1895.)	Formic Acid (Baud, 1913 (c).)
Benzoic Acid (Kendall, 1914.)	Methyl Alcohol (Pickering, 1893.)
Chlorobenzene (Baud, 1913 (c).)	Picric Acid (Kendall, 1916.)
Nitrobenzene (Dahms, 1895; Baud, 1913 (c).)	Propyl Alcohol (Pickering, 1893.)
Carbon Disulfide (Pickering, 1893.)	Sulfuric Acid (Pickering, 1893.)
Cyclohexane (Baud, 1913 (a) (b).)	Thymol (Paterno and Ampola, 1897.)
	p Xylene (Paterno and Ampola, 1897.)



## DISTRIBUTION OF ACETIC ACID BETWEEN:

Water and Amyl Alcohol at 20°.

(Herz and Fischer, 1904.)

Gms. CH <sub>3</sub> COOH per 100 cc.		G. M. CH <sub>3</sub> COOH per 100 cc.	
H <sub>2</sub> O Layer.	Alcoholic Layer.	H <sub>2</sub> O Layer.	Alcoholic Layer.
1	0.923	0.01	0.0095
2	1.847	0.03	0.0280
3	2.741	0.05	0.0460
4	3.694	0.07	0.0645
5	4.587	0.09	0.0830
6	5.475	0.11	0.1010
7	6.434	0.13	0.1190
8	7.328	...	...

Water and Benzene at 25°.

(Herz and Fischer, 1905.)

Gms. CH <sub>3</sub> COOH per 100 cc.		G. M. CH <sub>3</sub> COOH per 100 cc.	
H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>6</sub> Layer.	H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>6</sub> Layer.
5	0.130	0.05	0.0
10	0.417	0.10	0.0
20	1.55	0.20	0.0
30	3.03	0.30	0.0
40	4.95	0.50	0.0
..	...	0.70	0.0

NOTE. — The distribution results of Herz and co-workers are reported in millimoles per 10 cc. portions of each layer in the several cases. To obtain the figures given in the tables here shown, the original results, before and after calculating to gram quantities, were plotted on cross-section paper, and the curves thus obtained, readings for regular intervals of concentration of acetic acid in the aqueous layer were selected.

## DISTRIBUTION OF ACETIC ACID BETWEEN WATER AND BENZENE.

(Waddell, 1898; see also Lincoln, 1904.)

The measurements were made by adding varying amounts of benzene or water to 5 cc. of acetic acid and then running in water or benzene till saturation was reached. The observed readings were calculated to grams per 100 grams of liquid mixture.

t°.	Upper Layer.				Lower Layer.		
	CH <sub>3</sub> COOH.	C <sub>6</sub> H <sub>6</sub> .	H <sub>2</sub> O.		CH <sub>3</sub> COOH.	C <sub>6</sub> H <sub>6</sub> .	H <sub>2</sub> O.
25	0.46	99.52	0.02		9.4	0.18	90.42
25	3.10	96.75	0.15		28.2	0.53	71.27
25	5.20	94.55	0.25		37.7	0.84	61.46
25	8.7	90.88	0.42		48.3	1.82	49.88
25	16.3	82.91	0.79		61.4	6.1	32.5
25	30.5	67.37	2.13		66.0	13.8	20.2
25	52.5	39.60	7.60		52.8	39.6	7.6
35	1.2	98.68	0.08		16.4	0.62	82.98
35	5.7	93.97	0.33		36.8	1.42	62.78
35	9.0	90.42	0.58		49.0	2.10	48.90
35	45.0	49.00	6.0		61.3	25.5	13.2
35	52.2	39.4	8.4		52.2	39.4	8.4

Additional data in connection with the distribution of acetic acid between water and benzene are given by King and Narracutt (1909), Kuriloff (1911), Farmer (1903), Bubanovic (1913), and Lincoln (1904). This latter investigator points out that the same degree of clouding does not represent the end point in all cases as was assumed by Waddell (1900).

Data for the distribution of acetic acid between benzene and aqueous solutions of sodium acetate at 25° are given by Farmer (1903).



## DISTRIBUTION OF ACETIC ACID BETWEEN WATER AND CHLOROFORM:

At Room Temperature.

(Wright, Thomson and Leon — Proc. Roy. Soc. 49, 185, 1891.)

Results in parts per 100 parts of solution.		
Upper Layer.		Lower Layer.
CH <sub>3</sub> COOH. CHCl <sub>3</sub> .	H <sub>2</sub> O.	CH <sub>3</sub> COOH. CHCl <sub>3</sub> . H <sub>2</sub> O.
0	0.84	99.16
6.46	0.92	92.62
17.69	0.79	81.52
25.10	1.21	73.69
33.71	2.97	63.32
44.12	7.30	48.58
50.18	15.11	34.71

At 25°.

(Herz and Lewy; Rothmund and Wilmore.)

Gms. CH <sub>3</sub> COOH per 100 cc.		G. M. CH <sub>3</sub> COOH per 100 cc.	
H <sub>2</sub> O Layer.	CHCl <sub>3</sub> Layer.	H <sub>2</sub> O Layer.	CHCl <sub>3</sub> Layer.
2	0.089	0.05	0.0032
4	0.313	0.075	0.0062
6	0.596	0.100	0.0100
8	0.974	0.150	0.0198
10	1.430	0.175	0.0260
12	1.982	0.200	0.0325
20	5.10	0.30	0.070
30	10.2	0.50	0.170
40	15.3	0.70	0.275
50	21.9	0.80	0.335
52.3	39.54	0.87	0.659

See Note, page 6.

In addition to the above results, data for somewhat lower concentrations of acetic acid determined at 20° are given by Dawson and Grant (1901).

Results showing the influence of electrolytes upon the distribution of acetic acid between water and chloroform are given by Rothmund and Wilmore and by Dawson and Grant.

## DISTRIBUTION OF ACETIC ACID AT 25° BETWEEN:

Water and Carbon Disulphide.

(Herz and Lewy.)

Gms. CH <sub>3</sub> COOH per 100 cc.		G. M. CH <sub>3</sub> COOH per 100 cc.	
H <sub>2</sub> O Layer.	CS <sub>2</sub> Layer.	H <sub>2</sub> O Layer.	CS <sub>2</sub> Layer.
65	2.64	1.1	0.45
70	3.0	1.2	0.55
75	3.3	1.2	0.80
80	5.4	1.35	0.97
85	6.4	1.4	1.3

Water and Carbon Tetrachloride.

(Herz and Lewy.)

Gms. CH <sub>3</sub> COOH per 100 cc.		G. M. CH <sub>3</sub> COOH per 100 cc.	
H <sub>2</sub> O Layer.	CCl <sub>4</sub> Layer.	H <sub>2</sub> O Layer.	CCl <sub>4</sub> Layer.
30	1.8	0.5	0.03
40	3.0	0.7	0.055
50	4.8	0.9	0.095
60	5.8	1.1	0.155
70	12.0	1.2	0.235
76.2	25.2	1.27	0.420

Results for the distribution of acetic acid between water and mixtures of equal volumes of carbon disulfide and carbon tetrachloride at 25° are given by Herz and Kurzer (1910).

## DISTRIBUTION OF ACETIC ACID AT 25° BETWEEN:

Water and Bromoform.

(H. and L. — Z. electro. Ch. 11, 818, '05.)

Gms. CH <sub>3</sub> COOH per 100 cc.		G. M. CH <sub>3</sub> COOH per 100 cc.	
H <sub>2</sub> O Layer.	CHBr <sub>3</sub> Layer.	H <sub>2</sub> O Layer.	CHBr <sub>3</sub> Layer.
20	1.5	0.4	0.035
30	3.0	0.6	0.070
40	4.8	0.8	0.120
50	7.8	1.0	0.20
60	12.0	1.1	0.28
65	15.6	1.15	0.395
70	27.0	...	...

Water and Toluene.

(H. and F. — Ber. 38, 1140, '05.)

Gms. CH <sub>3</sub> COOH per 100 cc.		G. M. CH <sub>3</sub> COOH per 100 cc.	
H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> Layer.	H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> Layer.
5	0.119	0.1	0.0025
10	0.328	0.2	0.0075
20	1.132	0.4	0.0260
30	2.265	0.6	0.0530
40	3.725	0.8	0.090
50	5.841	1.0	0.140
60	8.344	...	...

See Note, page 6.



DISTRIBUTION OF ACETIC ACID BETWEEN WATER AND ETHYL ETHER.  
(de Kolosovsky, 1911.)

Results at Several Temperatures.				Results at 18°.		
°.	Gms. CH <sub>3</sub> COOH per 100 cc. of:			Gms. CH <sub>3</sub> COOH per 100 cc. of:		
	H <sub>2</sub> O Layer (g).	Ether Layer (g).	$\frac{g}{g}$ .	H <sub>2</sub> O Layer (g).	Ether Layer (g).	$\frac{g}{g}$ .
13	0.365	0.207	1.76	1.0	0.5	2.0
18	0.367	0.201	1.82	2.0	1.0	2.0
27	0.379	0.195	1.94	4.0	2.1	1.9
7.5	0.799	0.551	1.45	6.0	3.5	1.7
12	0.803	0.529	1.52	8.0	4.9	1.6
18	0.802	0.501	1.60	10.0	6.6	1.5
25	0.789	0.474	1.66	15.0	11.4	1.3
				20.0	17.0	1.2
				25.0	23.3	1.07

According to results obtained at 25° by Morgan and Benson (1907), the ratio of distribution for concentrations of acetic acid up to 12 grams per 100 cc. of the H<sub>2</sub>O layer is more nearly constant (1.92) than shown above for 18°. A similar constancy of distribution (approx. 2.08 at 15°) was also found by Pinnow (1915).

Results showing the influence of varying concentrations of a large number of electrolytes upon the distribution of acetic acid between water and ether are given by de Kolosovsky, Dubrisay (1912), and by Hantzsch and Vagt (1901).

Data for the distribution of acetic acid between ether and molten CaCl<sub>2</sub>·6H<sub>2</sub>O and ether and molten LiNO<sub>3</sub>·H<sub>2</sub>O are given by Morgan and Benson (1907).

One determination of the distribution of acetic acid between sat. aq. CaCl<sub>2</sub> solution (20 gms. per l.) and kerosene gave 97.7 gms. acid per 100 gms. aq. layer and 27 gms. per 100 gms. kerosene layer at ordinary temperature. (Crowell, 1918.)

DISTRIBUTION OF ACETIC ACID AT 25° BETWEEN:

Water and *o* or *p* Xylene.  
(Herz and Fischer.)

Gms. CH <sub>3</sub> COOH per 100 cc.		G. M. CH <sub>3</sub> COOH per 100 cc.	
H <sub>2</sub> O Layer.	<i>o</i> or <i>p</i> Xylene Layer.	H <sub>2</sub> O Layer.	<i>o</i> or <i>p</i> Xylene Layer.
5	0.24	0.1	0.004
10	0.48	0.2	0.010
20	1.13	0.4	0.025
30	2.15	0.6	0.047
40	3.40	0.8	0.079
50	5.10	1.0	0.122
60	7.27	1.2	0.230
70	12.52	...	...

Water and *m* Xylene.  
(Herz and Fischer.)

Gms. CH <sub>3</sub> COOH per 100 cc.		G. M. CH <sub>3</sub> COOH per 100 cc.	
H <sub>2</sub> O Layer.	<i>m</i> Xylene Layer.	H <sub>2</sub> O Layer.	<i>m</i> Xylene Layer.
5	0.06	0.1	0.0015
10	0.30	0.2	0.007
20	0.95	0.4	0.022
30	1.91	0.6	0.042
40	3.04	0.8	0.072
50	4.65	1.0	0.111
60	6.65	1.2	...

See Note, page 6.

Data showing effect of camphor on the reciprocal solubility of acetic acid and olive oil are given by Wingard, 1917.



ChloroACETIC ACIDS  $\text{CH}_3\text{ClCOOH}$ ,  $\text{CHCl}_2\text{COOH}$ , and  $\text{CCl}_3\text{COOH}$ .

SOLUBILITY OF THE  $\alpha$ ,  $\beta$ , AND  $\gamma$  MODIFICATION OF MONOCHLOROACETIC ACID  
IN WATER AT DIFFERENT TEMPERATURES.  
(Miers and Isaac, 1908; Pickering, 1895.)

The determinations were made by the sealed tube method. The following figures were obtained by plotting the original results on cross-section paper:

Gms. per 100 Gms. of Each Sat. Solution.				Gms. per 100 Gms. of Each Sat. Solution.			
t°.	$\alpha$ Modifi- cation.	$\beta$ Modifi- cation.	$\gamma$ Modifi- cation.	t°.	$\alpha$ Modifi- cation.	$\beta$ Modifi- cation.	$\gamma$ Modifi- cation.
20	...	...	88.0	50	95.0	97.0	99.6
25	...	85.8	90.0	51 (m. pt.)	...	...	100.0
30	86.0	88.2	92.2	55	97.2	99.3	...
35	88.4	90.6	94.1	56.5 (m. pt.)	...	100.0	...
40	90.8	93.0	95.8	60	99.0	...	...
45	93.0	95.0	97.8	62.4 (m. pt.)	100.0	...	...

Reciprocal solubilities of mono-, di-, and trichloroacetic acids and water determined by the freezing-point method are given by Pickering (1895).

SOLUBILITY OF TRICHLOROACETIC ACID IN WATER AT 25°.  
(Seidell, 1910.)

100 gms. saturated solution of  $d_{25} = 1.615$  contain 92.32 gms.  $\text{CCl}_3\text{COOH}$ .

SOLUBILITY DATA DETERMINED BY THE METHOD OF LOWERING OF THE FREEZING-POINT (see footnote, page 1) ARE GIVEN FOR MIXTURES OF Chloroacetic Acid AND EACH OF THE FOLLOWING COMPOUNDS:

Dichloroacetic Acid (Kendall, 1914.)	Dimethyl Oxalate (Kendall and Booge, 1916.)
Trichloroacetic Acid (Kendall, 1914.)	Dimethyl Succinate (Kendall and Booge, 1916.)
Acetophenone (Kendall and Gibbons, 1915.)	Dimethylpyrone (Kendall, 1914 (a).)
Dibenzyl Acetone (Kendall and Gibbons, 1915.)	Naphthalene (Miers & Isaac, 1908; M. & M., 1913.)
Benzil (Kendall and Gibbons, 1915.)	Phenol (Kendall, 1916.)
Benzene (Kendall and Booge, 1916.)	Piperonal (Kendall & Gibbons, 1915; M. & M., 1913.)
Benzoic Acid (Kendall, 1914.)	Salol (Mameli and Mannesier, 1913.)
Camphor (Pawlewski, 1893.)	Sulfuric Acid (Kendall and Carpenter, 1914.)
Cinnamic Acid (Kendall, 1914.)	<i>o</i> Toluic Acid (Kendall, 1914.)
Crotonic Acid "	<i>m</i> " " "
Cetyl Alcohol (Mameli and Mannesier, 1913.)	<i>p</i> " " "
<i>o</i> Creosol (Kendall, 1914.)	$\alpha$ " " "
Methyl Cinnamate (Kendall and Booge, 1916.)	Vanillin (Kendall and Gibbons, 1915.)

SOLUBILITY DATA DETERMINED BY THE METHOD OF LOWERING OF THE FREEZING-POINT (see footnote, page 1) ARE GIVEN BY KENDALL (1914) FOR MIXTURES OF Dichloroacetic Acid AND EACH OF THE FOLLOWING COMPOUNDS:

Trichloroacetic Acid	<i>o</i> Toluic Acid
Benzoic Acid	<i>m</i> " "
Cinnamic Acid	<i>p</i> " "
Crotonic Acid	$\alpha$ " " (Phenylacetic Acid)
Dimethylpyrone	



SOLUBILITY DATA DETERMINED BY THE METHOD OF LOWERING OF THE FREEZING-POINT (see footnote, page 1) ARE GIVEN FOR MIXTURES OF **Trichloroacetic Acid** AND EACH OF THE FOLLOWING COMPOUNDS:

Acetophenone (Kendall and Gibbons, 1915.)	Ethyl Ether (Tsakalotos and Guye, 1910.)
Anisaldehyde " "	Ethyl Acetate (Kendall and Booge, 1916.)
Benzene (Kendall and Booge, 1916.)	Ethyl Benzoate " "
Benzaldehyde (Kendall and Gibbons, 1915.)	Methyl Benzoate " "
<i>m</i> Hydroxy Benzaldehyde	" Anisate " "
<i>p</i> " " " "	" Cinnamate " "
<i>o</i> Nitro Benzaldehyde	" <i>p</i> Toluate " "
<i>m</i> " " " "	$\alpha$ Naphthol (Kendall, 1916.)
<i>p</i> " " " "	$\beta$ " " " "
Benzophenone	$\alpha$ Naphthyl Acetate (Kendall and Booge, 1916.)
Benzil	$\beta$ " " " "
Benzoquinone	Phenol (Kendall, 1916.)
Benzoic Acid (Kendall, 1914.)	<i>o</i> Nitro Phenol (Kendall, 1916.)
Camphene (Timofeiev & Kravtsov, 1915, 1917.)	<i>m</i> " " " "
Cinnamic Acid (Kendall, 1914.)	<i>p</i> " " " "
Crotonic Acid " "	Piperonal (Kendall and Gibbons, 1915.)
<i>o</i> Cresol (Kendall, 1914.)	Nitro Piperonal " "
<i>m</i> " " " "	Phenyl Anisylketone " "
<i>p</i> " " " "	" Benzoate (Kendall and Booge, 1916.)
Diethyl Oxalate (Kendall and Booge, 1916.)	" Salicylate " "
Diethyl Succinate " "	Salicylic Aldehyde (Kendall and Gibbons, 1915.)
Dimethyl Oxalate " "	Sulfuric Acid (Kendall and Carpenter, 1914.)
Dimethyl Malonate " "	<i>o</i> Toluic Acid (Kendall, 1914.)
Dimethyl Succinate " "	<i>m</i> " " " "
Dimethyl Terephthalate (Kendall and Booge, 1916.)	<i>p</i> " " " "
Dimethylpyrone (Plotnikov, 1911; Kendall, 1914 (a).)	$\alpha$ " " " "
	Thymol (Kendall, 1916.)
	Vanillin (Kendall and Gibbons, 1915.)

#### DISTRIBUTION OF CHLORACETIC ACID BETWEEN:

(Herz and Fischer.)

Water and Benzene at 25°.				Water and Toluene at 25°.			
Gms. CH <sub>2</sub> ClCOOH per 100 cc.		G. M. CH <sub>2</sub> ClCOOH per 100 cc.		Gms. CH <sub>2</sub> ClCOOH per 100 cc.		G. M. CH <sub>2</sub> ClCOOH per 100 cc.	
H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>6</sub> Layer.	H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>6</sub> Layer.	H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> Layer.	H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> Layer.
0.25*	8.69	0.0025	0.090	0.1*	5.22	0.001	0.055
0.5	15.59	0.005	0.155	0.5	20.31	0.005	0.20
1.0	27.87	0.010	0.28	1.0	34.87	0.010	0.36
1.5	41.10	0.015	0.415	1.5	49.14	0.015	0.50
2.0	52.90	0.02	0.54	2.0	60.46	0.02	0.62
3.0	68.01	0.03	0.70	3.0	72.28	0.03	0.77
4.0	76.52	0.04	0.79	4.0	81.72	0.04	0.85
				5.0	86.94	0.05	0.90

\* See Note, page 6.

Additional data for the distribution of monochloroacetic acid between water and benzene as well as similar results for dichloroacetic acid are given by Georgievics, 1915.



## DISTRIBUTION OF CHLORACETIC ACID BETWEEN:

(Hers and Levy.)

Water and Chloroform at 25°.				Water and Bromoform at 25°.			
Gms. CH <sub>2</sub> ClCOOH per 100 cc.		G. M. CH <sub>2</sub> ClCOOH per 100 cc.		Gms. CH <sub>2</sub> ClCOOH per 100 cc.		G. M. CH <sub>2</sub> ClCOOH per 100 cc.	
H <sub>2</sub> O Layer.	CHCl <sub>3</sub> Layer.	H <sub>2</sub> O Layer.	CHCl <sub>3</sub> Layer.	H <sub>2</sub> O Layer.	CHBr <sub>3</sub> Layer.	H <sub>2</sub> O Layer.	CHBr <sub>3</sub> Layer.
5*	0.283	0.05	0.0025	40*	0.850	0.45	0.011
10	0.614	0.10	0.0060	50	1.889	0.50	0.0165
20	1.088	0.20	0.0135	60	2.994	0.60	0.028
40	2.948	0.40	0.029	70	4.241	0.70	0.040
50	3.684	0.60	0.045	80	5.620	0.80	0.053
60	4.440	0.70	0.061	90	7.560	0.90	0.067
70	7.086	0.75	0.077	91.6	11.340	0.97	0.120

## DISTRIBUTION OF CHLORACETIC ACID BETWEEN:

(Hers and Levy.)

Water and Carbon Disulphide at 25°.				Water and Carbon Tetra- chloride at 25°.			
Gms. CH <sub>2</sub> ClCOOH per 100 cc.		G. M. CH <sub>2</sub> ClCOOH per 100 cc.		Gms. CH <sub>2</sub> ClCOOH per 100 cc.		G. M. CH <sub>2</sub> ClCOOH per 100 cc.	
H <sub>2</sub> O Layer.	CS <sub>2</sub> Layer.	H <sub>2</sub> O Layer.	CS <sub>2</sub> Layer.	H <sub>2</sub> O Layer.	CCl <sub>4</sub> Layer.	H <sub>2</sub> O Layer.	CCl <sub>4</sub> Layer.
60*	0.426	0.6	0.0042	90*	1.417	0.95	0.0156
80	0.691	0.8	0.007	95	2.031	1.00	0.0195
90	0.803	1.0	0.009	100	2.645	1.05	0.0270
100	1.040	1.05	0.0105	105	4.26	1.10	0.0415
105	1.464	1.10	0.015	106.7	5.19	1.13	0.0550
106.7	1.890	1.13	0.020				

\* See Note, page 6.

Results showing the influence of sulfuric acid upon the distribution of mono-chloroacetic acid between water and ethyl ether at 26° are given by Hantzsch and Vagt (1901).

CYANOACETIC ACID CH<sub>2</sub>(CN)COOH.

## DISTRIBUTION OF CYANOACETIC ACID BETWEEN:

(Hantzsch and Sebalt, 1899.)

Water and Ethyl Ether.			Water and Benzene.		
°.	Gms. CH <sub>2</sub> (CN)COOH per Liter.		°.	Gms. CH <sub>2</sub> (CN)COOH per Liter.	
	H <sub>2</sub> O Layer.	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O Layer.		H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>6</sub> Layer.
0	0.070	0.042	6	0.067	0.020
10	0.076	0.044	25	0.130	0.019
21	0.083	0.030			
30	0.089	0.027			



# Phenyl**ACETIC ACID**

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## Phenyl**ACETIC ACID** ( $\alpha$ Toluic Acid) $\text{CH}_2(\text{C}_6\text{H}_5)\text{COOH}$ .

### SOLUBILITY IN WATER AND IN ALCOHOLS. (Timofeiew, 1894.)

Solvent.	t°.	Gms. $\text{CH}_2(\text{C}_6\text{H}_5)\text{COOH}$ per 100 Gms. Sat. Sol.	Solvent.	t°.	Gms. $\text{CH}_2(\text{C}_6\text{H}_5)\text{COOH}$ per 100 Gms. Sat. Sol.
Water	20	1.64	Ethyl Alcohol	0.0	50.7
Methyl Alcohol	-17	50.6	"	+19.4	64.4
"	-13	53.2	"	20.0	65.1
"	0	59.2	Propyl Alcohol	-17.0	29.4
"	+19.4	70.8	"	-13.0	32.3
"	20	71.8	"	0.0	40.9
Ethyl Alcohol	-17	39.7	"	+19.4	56.8
"	-13	41.5	"	20.0	57.2

### SOLUBILITY OF PHENYLACETIC ACID IN SEVERAL SOLVENTS AT 25°.

(Hetz and Rathmann, 1913.)

Solvent.	Gms. $\text{CH}_2(\text{C}_6\text{H}_5)\text{COOH}$ per 100 cc. Sat. Sol.	Solvent.	Gms. $\text{CH}_2(\text{C}_6\text{H}_5)\text{COOH}$ per 100 cc. Sat. So
Chloroform	60.17	Tetrachlorethylene	21.19
Carbon Tetrachloride	25.07	Tetrachlorethane	61.45
Trichlorethylene	44.89	Pentachlorethane	44.26

The freezing-point curve (Solubility, see footnote, page 1) is given by Salkowski (1885) for mixtures of phenylacetic acid and hydrocinnamic acid.

## **ACETIC ACID ESTERS.**

### SOLUBILITIES OF SEVERAL ACETIC ACID ESTERS IN AQUEOUS ALCOHOL AT ROOM TEMPERATURE. (Pfeiffer, 1892.)

cc. Ethyl Alcohol in Mixtures.	cc. $\text{H}_2\text{O}$ added to cause separation of a second phase in mixtures of the given amounts of Alcohol and 3 cc. of:				
	$\text{CH}_3\text{COOC}_2\text{H}_5$	$\text{CH}_3\text{COOC}_2\text{H}_7$	$\text{CH}_3\text{COOC}_4\text{H}_9$	$\text{CH}_3\text{COOC}_6\text{H}_{13}$	$\text{CH}_3\text{COOC}_8\text{H}_{17}$
3	$\infty$	6.0	4.50	2.08	1.76
6	...	$\infty$	10.48	6.08	4.24
9	...	...	17.80	10.46	9.03
12	...	...	26.00	15.37	13.24
15	...	...	35.63	20.42	17.52
18	...	...	47.50	26.60	22.22
21	...	...	58.71	31.49	26.99
24	...	...	$\infty$	37.48	32.14
27	...	...	...	43.75	37.23
30	...	...	...	50.74	42.06
33	...	...	...	59.99	48.41

## Chloro**ACETIC ACID ESTERS.**

### SOLUBILITY OF MONOCHLOR, DICHLOR, AND OF TRICHLORACETIC ESTER IN AQUEOUS ALCOHOL AT ROOM TEMPERATURE.

(Bancroft — Phys. Rev. 3, 193, 1895-96, from results of Pfeiffer, Z. physik. chem. 9, 469, '98.)

cc. Ethyl Alcohol in Mixtures.	cc. $\text{H}_2\text{O}$ added to cause separation of a second phase in mixtures of the given amts. of Alcohol and 3 cc. of:		
	$\text{CH}_2\text{ClCOOC}_2\text{H}_5$	$\text{CHCl}_2\text{COOC}_2\text{H}_5$	$\text{CCl}_3\text{COOC}_2\text{H}_5$
3	1.32	0.90	0.65
6	4.01	2.45	1.80
9	7.30	4.33	3.02
12	10.78	6.60	4.50
15	16.16	9.20	6.50
18	22.16	...	...
21	28.74	...	...



Mono-, Di-, and Tri **ACETIN**  $C_3H_5(OH)_2(OC_2H_5O)$ ,  $C_3H_5(OH)(OC_2H_5O)_2$ , and  $C_3H_5(OC_2H_5O)_3$ .

The partition coefficients of these three compounds between olive oil and water are given by Baum (1899) and Meyer (1901, 1909), as 0.06, 0.23, and 0.3 respectively.

Meth**ACETIN** (*p* Acetanisidine, or *p* oxymethylacetanilide)  $C_6H_4.OCH_3.NHCH_2CO$ .

100 gms.  $H_2O$  dissolve 0.19 gms. of the compound at  $15^\circ$  and 8.3 gms. at  $100^\circ$ .  
(German Pharmacopoeia.)

$\alpha$  **ACETNAPHTHALIDE**  $C_{10}H_7ONH(C_2H_5)$ .

#### SOLUBILITY IN MIXTURES OF ALCOHOL AND WATER AT $25^\circ$ .

(Holleman and Antusch — Rec. trav. chim. 13, 289, 1894.)

Vol. % Alcohol.	Gms. per 100 Gms. Solvent.	Sp. Gr. of Solutions.	Vol. % Alcohol.	Gms. per 100 Gms. Solvent.	Sp. Gr. of Solutions.
100	4.02	0.7916	65	1.78	0.8977
95	4.31	0.8150	60	1.44	0.9091
90	4.11	0.8344	55	1.02	0.9201
85	3.69	0.8485	50	0.71	0.9290
80	3.18	0.8624	35	0.25	0.9537
75	2.73	0.8761	20	0.09	0.9717
70	2.31	0.8798	10	0.04	0.9841

Constant agitation was not employed. The mixtures were allowed to stand in bath and the solutions analyzed after different lengths of time. Formulas are not given. This applies to all determinations by Holleman and Antush.

#### ACETONE $(CH_3)_2CO$ .

##### SOLUBILITY OF ACETONE AT $25^\circ$ IN AQUEOUS SOLUTIONS OF:

###### Electrolytes.

###### Non-Electrolytes.

(Bell — J. Phys. Ch. 9, 544, 1905; Linebarger — Am. Ch. J. 14, 380, 1892.)

Gms. Electro- lyte per 100 Gms. Aq. Solution.	Gms. $(CH_3)_2CO$ per 100 Gms. Solvent in Solutions of:				Gms. Non- Electrolyte per 100 Gms. Aq. Solution.	Gms. $(CH_3)_2CO$ per 100 Gms. Solvent in Solutions of:		
	$K_2CO_3$	$Na_2CO_3$	$(NH_4)_2CO_3$	$MgCO_3$		$C_{10}H_8$ †	Anethol.*	$(C_6H_5)_2CO$
1.25	...	...	...	83.5	5	92.5	103.0	90.0
2.50	...	51.0	110.0	65.0	10	117.0	123.0	108.5
5.00	65.0	38.0	73.5	47.0	20	137.0	144.5	126.0
7.5	46.5	27.5	57.0	38.0	30	148.5	155.0	133.0
10.0	34.5	19.5	44.5	29.0	40	155.5	162.0	136.0
12.5	25.5	14.0	35.0	...	50	159.5	166.0	135.5
15.0	18.0	9.0	28.0	...	60	160.2	165.0	131.5
20.0	8.0	2.7	...	...	70	155.0	158.0	123.0
25.0	3.7	...	...	...	80	...	...	108.5
30.0	1.6	...	...	...	90	...	...	82.0

\* Anethol = *p* Propenylanisol,  $CH_3CH:CH.C_6H_4OCH_3$ .

† Naphthalene results at  $35^\circ$ .

NOTE. — In the case of the results for the aqueous solutions of electrolytes, the determinations were made by adding successive small quantities of acetone to the mixtures of given amounts of water and electrolyte, and noting the point at which a clouding, due to the separation of a second phase, occurred. In the case of the aqueous non-electrolyte solutions, successive small amounts of water were added to mixtures of known amounts of acetone and the non-electrolyte. In all cases the results, as given in the original papers, have been recalculated and plotted on cross-section paper. From the curves so obtained, the above table was constructed.

Additional data for systems containing acetone are given under the salt involved, as, for instance, Potassium Carbonate, p. 511, Potassium Fluoride, p. 534, etc.



## MISCIBILITY OF ACETONE AT 0° WITH MIXTURES OF:

Chloroform and Water (Bonner, 1910).				Bromobenzene and Water (Bonner, 1910).			
Gms. CHCl <sub>3</sub> .	Gms. H <sub>2</sub> O.	Gms. (CH <sub>3</sub> ) <sub>2</sub> CO.	Sp. Gr. of Mixture.	Gms. C <sub>6</sub> H <sub>5</sub> Br.	Gms. H <sub>2</sub> O.	Gms. (CH <sub>3</sub> ) <sub>2</sub> CO.	Sp. Gr. of Mixture.
0.088	0.012	0.501	1.18	0.977	0.023	0.685	1.18
0.900	0.100	1.300	1.01	0.90	0.10	1.13	1.01
0.792	0.208	1.633	0.98	0.80	0.20	1.41	0.98
0.696	0.304	1.750	0.96	0.70	0.30	1.52	0.96
0.600	0.400	1.770	0.95	0.60	0.40	1.57	0.95
0.500	0.500	1.720	0.94	0.50	0.50	1.60	0.94
*0.420	0.580	1.650	...	*0.49	0.51	1.60	...
0.400	0.600	1.630	0.93	0.40	0.60	1.59	0.93
0.300	0.700	1.530	0.94	0.30	0.70	1.55	0.94
0.200	0.800	1.321	0.95	0.20	0.80	1.46	0.95
0.100	0.900	1.144	0.97	0.10	0.90	1.30	0.97
0.018	0.982	0.464	0.98	0.02	0.98	0.849	0.98

NOTE. — The determinations were made by gradually adding acetone to mixtures of the given amounts of water and the other constituent until a homogeneous solution was obtained. The results give the binodal curve for the system. The author also determined "tie lines" showing the compositions of various pairs of liquids which may exist in equilibrium. When the two liquids are practically of the same composition the tie line is reduced to a point designated as the "plait point" of the binodal curve. This point is indicated by \* in the above tables.

## SOLUBILITY OF ACETONE IN AQUEOUS SOLUTIONS OF CARBOHYDRATES:

(Krug and McElroy — J. Anal. Ch. 6, 184, '92; Bell — J. Phys. Ch. 9, 547, '05.)

## In Aqueous Solutions of Cane Sugar.

Per cent Sugar.	Gms. (CH <sub>3</sub> ) <sub>2</sub> CO per 100 Gms. Sugar Solution at:					
	15°.	20°.	25°.	30°.	35°.	40°.
10	597.2	...	581.8	...	574.8	...
20	272.5	...	250.0	...	251.8	...
30	172.4	...	150.0	...	150.6	...
35	...	...	...	...	...	110
40	...	96.4	92.8	89.8	...	85
45	...	71.9	68.8	65.7	...	62
50	...	50.8	48.1	45.9	...	42
55	...	35.8	33.8	32.5	...	29
60	...	25.2	24.2	23.4	...	...
65	...	18.3	17.7	17.0	...	...
70	...	13.2	12.8	12.5	...	...

## In Aqueous Dextrose Solutions.

## In Aqueous Maltose Solutions.

Per cent Dextrose.	Gms. (CH <sub>3</sub> ) <sub>2</sub> CO per 100 Gms. Solvent at:			Per cent Maltose.	Gms. (CH <sub>3</sub> ) <sub>2</sub> CO per 100 Gms. Solvent at:		
	15°.	25°.	35°.		15°.	25°.	35°.
10	736.7	747.9	761.5	10	353.6	348.1	342.0
20	255.3	247.7	240.8	20	185.4	181.2	176.9
30	157.5	149.8	142.5	30	119.9	116.0	112.4
40	86.9	79.6	74.0	40	78.4	74.7	70.5
50	36.2	33.0	31.2	50	46.2	42.9	39.8

The determinations were made as in the case of the solubility of acetone in aqueous solutions of electrolytes. See preceding page.



## DISTRIBUTION OF ACETONE BETWEEN:

Benzene and Water.				Toluene and Water.		
Results at 20°.		Results at 25°.		At Different Temps.		
(Philip and Bramby, 1915.)		(Herr and Fischer, 1905.)		(Hantzsch and Vagt, 1901.)		
Gms. (CH <sub>3</sub> ) <sub>2</sub> CO per 1000 cc.		Gms. (CH <sub>3</sub> ) <sub>2</sub> CO per 1000 cc.			Gms. (CH <sub>3</sub> ) <sub>2</sub> CO per 1000 cc.	
H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>6</sub> Layer.	H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>6</sub> Layer.	t°.	H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> Layer.
0.10	0.08	10*	12.0	0	2.105	0.993
0.20	0.12	50	41.7	10	2.000	0.957
0.30	0.25	100	101.5	20	1.960	0.957
0.40	0.34	150	155.9	30	1.867	0.957
...	...	200	225.0	...	...	...

\* See Note, page 6.

Philip and Bramby also give data for the effect of NaCl, KCl and LiCl upon the distribution of acetone between benzene and water.

In the determinations by Hantzsch and Vagt the equilibrium was approached from above. The amount of acetone in the lower layer was determined by analysis, and that in the upper layer calculated by difference.

## DISTRIBUTION OF ACETONE BETWEEN:

(Herz and Rathmann, 1913.)

Water and Carbon Tetrachloride.		Water and Chloroform.		Water and Pentachlorethane.	
Mols. (CH <sub>3</sub> ) <sub>2</sub> CO per Liter.		Mols. (CH <sub>3</sub> ) <sub>2</sub> CO per Liter.		Mols. (CH <sub>3</sub> ) <sub>2</sub> CO per Liter.	
H <sub>2</sub> O Layer.	CCl <sub>4</sub> Layer.	H <sub>2</sub> O Layer.	CHCl <sub>3</sub> Layer.	H <sub>2</sub> O Layer.	C <sub>2</sub> HCl <sub>3</sub> Layer.
0.186	0.0833	0.032	0.168	0.144	0.251
0.322	0.146	0.0781	0.399	0.271	0.469
1.01	0.514	0.145	0.676	0.541	0.859
1.66	0.997	0.263	1.17	0.806	1.275
2.87	2.10	0.493	1.98	1.149	1.763
...	...	1.01	3.06	...	...

Water and Tetrachlorethane.		Water and Tetrachlorethylene.		Water and Trichlorethylene.	
Mols. (CH <sub>3</sub> ) <sub>2</sub> CO per Liter.		Mols. (CH <sub>3</sub> ) <sub>2</sub> CO per Liter.		Mols. (CH <sub>3</sub> ) <sub>2</sub> CO per Liter.	
H <sub>2</sub> O Layer.	C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub> Layer.	H <sub>2</sub> O Layer.	CCl <sub>2</sub> :CCl <sub>2</sub> Layer.	H <sub>2</sub> O Layer.	CHCl:CCl <sub>2</sub> Layer.
0.0812	0.341	0.274	0.081	0.160	0.193
0.249	0.994	0.562	0.174	0.350	0.359
0.317	1.210	1.020	0.343	0.654	0.719
0.363	1.323	1.545	0.629	0.946	1.029
0.569	1.936	2.007	0.891	1.389	1.562

The distribution coefficient of acetone between olive oil and water is given by Meyer (1901), as 0.146 at 3° and 0.235 at 30°.

SOLUBILITY DATA DETERMINED BY THE METHOD OF LOWERING OF THE FREEZING-POINT (see footnote, p. 1) ARE GIVEN FOR MIXTURES OF Acetone AND EACH OF THE FOLLOWING COMPOUNDS:

Bromine	(Maass and McIntosh, 1912.)	Phenol	(Schmidlin and Lang, 1910.)
Chlorine	"	Resorcinol	"
Hydrobromic Acid	"	Pyrogallol	"
Chloroform	(Tsikalotos and Guye, 1910.)	Pyrocatechol	"
<i>o</i> Chlorophenol	(Bramby, 1916.)		

Depression of the freezing-point of mixtures of acetone and water and each of the following compounds are given by Waddell (1899): Ether, hydroquinone, phenol, *p* nitrophenol, salicylic acid.



**ACETOPHENONE**  $\text{CH}_3\text{COC}_6\text{H}_5$ .

The freezing-point curve for mixtures of acetophenone and sulfuric acid is given by Kendall and Carpenter (1914).

Freezing-point curves (solubility, see footnote, page 1) for mixtures of Cinna-  
mylidene **Acetophenone** and each of the following compounds are given by  
Giua (1916): Acenaphthene, azobenzene, ethyl ether and  $\alpha$  trinitrotoluene.

**ACETYLACETONE**  $\text{CH}_3\text{COCH}_2\text{COCH}_3$ .

## SOLUBILITY IN WATER.

(Rothmund — Z. phys. Ch. 26, 475, '98.)

t°.	Gms. $\text{CH}_3\text{COCH}_2\text{COCH}_3$ per 100 Gms.	
	H <sub>2</sub> O Layer.	Acetyl Acetone Layer.
30	15.46	95.02
40	17.58	93.68
50	20.22	91.90
60	23.23	89.41
70	27.10	85.77
80	33.92	78.82
87.7 (crit. temp.)	56.8	

NOTE. — Weighed amounts of water and acetyl acetone were placed in small glass tubes, which were then sealed and slowly heated until the contained mixtures became homogeneous. The temperature was then allowed to fall very gradually and the point noted at which cloudiness appeared. This point was accurately established for each tube by repeated trials. The curve plotted from these determinations shows two percentage amounts of acetyl acetone which cause cloudiness at each temperature below the critical point. Of these two points, for each temperature, one represents the aqueous layer, *i.e.*, the solubility of acetyl acetone in water; and the other represents the acetyl acetone layer, *i.e.*, the solubility of water in acetyl acetone. This method is known as the 'Synthetic Method,' and yields results in harmony with those obtained by the analytical method, *i.e.*, by analyzing each layer after complete separation occurs. See also, chapter on Methods of Solubility Determinations.

**ACETYLENE**  $\text{C}_2\text{H}_2$ .

## SOLUBILITY IN WATER.

(Winkler; see Landolt and Börnstein's Tabellen, 3d ed. p. 604, '05.)

t°.	a.	g.
0	1.73	0.20
5	1.49	0.17
10	1.31	0.15
15	1.15	0.13
20	1.03	0.12
25	0.93	0.11
30	0.84	0.09

a, "Absorption Coefficient," = the volume of gas (reduced to 0° and 760 mm. pressure) taken up by one volume of the liquid at the given temperature when the partial pressure of the gas equals 760 mm. mercury.

g, "Solubility," = the amount of gas in grams which is taken up by 100 grams of the pure solvent at the given temperature if the total pressure, *i.e.*, the partial pressure of the gas plus the vapor pressure of the liquid at the absorption temperature, is 760 mm.



**SOLUBILITY OF ACETYLENE IN WATER, AQUEOUS SOLUTIONS OF ALKALIES AND  
SULFURIC ACID AT 15°.**  
(Billitzer, 1902.)

Aq. Solution of:	<i>l<sub>15</sub></i> of Acetylene in Aq. Solutions of Normality:									
	0.01	0.025	0.05	0.10	0.15	0.25	0.50	1.00	2.00	3.00
Ba(OH) <sub>2</sub>	...	1.218	...	1.230	1.240	...	...	...	...	...
Ca(OH) <sub>2</sub>	1.230	...	...	...	...	...	...	...	...	...
NH <sub>4</sub> OH	1.216	...	...	1.218	...	1.220	1.225	1.230	1.235	1.240
NaOH	1.210	...	1.200	1.180	...	1.128	1.040	0.885	0.600	0.370
KOH	1.212	...	...	1.185	...	1.130	1.056	0.912	0.660	0.460
Na <sub>2</sub> SO <sub>4</sub>	...	...	...	1.170	...	1.068	0.940	0.720	0.340	...
H <sub>2</sub> SO <sub>4</sub>	...	...	...	1.190	...	...	1.120	1.040	0.900	0.780

SOLUBILITY IN WATER, *l<sub>15</sub>* = 1.251.

The above results were determined by the method of Ostwald (Handbuch physiko-chemischen Messungen 207 ff.). A thermostat was used and great care taken to reduce experimental errors and purify the acetylene. The results are in terms of the *Ostwald Solubility Expression*, for which see page 227, following.

**SOLUBILITY OF ACETYLENE IN AQUEOUS ACETONE SOLUTIONS.**  
(Kremann and Hönel, 1913.)

Vol. Per Cent H <sub>2</sub> O in Solvent (H <sub>2</sub> O + Acetone).	Gms. C <sub>2</sub> H <sub>2</sub> dissolved per Liter Sat. Solution at:		
	0°	18°	25°
0	37	21	15.2
5	31	18.2	13.5
10	26	15.0	10.5
20	15	9.5	8.0
35	8.4	5.5	4.45
50	5.7	1.23	2.22
75	...	...	1.23
100	...	...	0.98

The freezing-point curve for mixture of acetylene and methyl ether are given by Baume and German (1911, 1914).

**ACETYLENE** Biiodide, *cis* and *trans*.

Data for the lowering of the freezing-points of mixtures of these two isomers are given by Chavanne and Vos (1914).

**ACONITIC ACID** C<sub>3</sub>H<sub>3</sub>(COOH)<sub>2</sub>.

100 grams of formic acid (95% HCOOH) dissolve 2.01 grams C<sub>3</sub>H<sub>3</sub>(COOH)<sub>2</sub> at 20.6° C. (Aschan, 1913.)

**ACONITINE** (Amorphous) C<sub>34</sub>H<sub>47</sub>NO<sub>11</sub>.

**SOLUBILITY IN SEVERAL SOLVENTS.**

(At 25° U.S.P.; at 18°-22°, Müller — Apoth.-Ztg. 18, 2, '03.)

Solvent.	Gms. C <sub>34</sub> H <sub>47</sub> NO <sub>11</sub> per 100 Gms. Solvent at:		Solvent	Gms. C <sub>34</sub> H <sub>47</sub> NO <sub>11</sub> per 100 Gms. Solvent at:	
	18°-22°.	25°.		18°-22°.	25°.
Water . . .	0.054	0.031	Benzene . . . . .	...	17.85
Alcohol . . .	...	4.54	Carbon Tetrachloride	1.99	...
Ether . . .	1.44	2.27	Petroleum Ether . .	0.023	0.028

100 gms. H<sub>2</sub>O dissolve 0.0226 gm. aconitine at 22° (Dunstan and Umney, 1892.)  
 " " abs. alcohol " 2.7 " " " " (Jürgens, 1885.)  
 " " ether " 1.56 " " " "



# TrichloroACRYLIC ACID

18

## TrichloroACRYLIC ACID $\text{CCl}_3\text{:CClCOOH}$ .

### SOLUBILITY OF TRICHLOROACRYLIC ACID IN WATER

(Boeseken and Carriere, 1915.)

°.	Gms. $\text{CCl}_3\text{:CClCOOH}$ per 100 Gms. Sat. Solution.	Solid Phase.	Between the concentration 4.5 and 64.1 two liquid layers are formed. The percentage of $\text{CCl}_3\text{:CClCOOH}$ in each is as follows:		
			°.	Gms. $\text{CCl}_3\text{:CClCOOH}$ per 100 Gms. Sat. Solution.	
0.0	0.0	Ice		Lower Layer.	Upper Layer.
-0.36	2.0	"			
-0.6 Eutec.	4.5	Ice + $\text{CCl}_3\text{:CClCOOH} \cdot \frac{1}{2} \text{H}_2\text{O}$			
+13.7 "	64.1	$\text{CCl}_3\text{:CClCOOH} \cdot \frac{1}{2} \text{H}_2\text{O}$			
15.0	68.5	"			
17.0	74.5	"	10	5.0	...
19.2 m. pt.	80.0	"	20	5.2	64.1
17.0 Eutec.	81.1	$\text{CCl}_3\text{:CClCOOH} +$ $\text{CCl}_3\text{:CClCOOH} \cdot \frac{1}{2} \text{H}_2\text{O}$	30	6.0	63.8
		$\text{CCl}_3\text{:CClCOOH}$	40	7.5	62.2
20.3 "	82.8	"	50	13.0	59.5
25.0	84.5	"	55	18.0	56.0
30.0	86.0	"	60	27.0	49.0
40.0	89.5	"	62 crit. t.	38.0	
50.0	92.5	"			
60.0	94.5	"			
70.0	98.5	"			
72.9	100.0	"			

The original results were plotted on cross-section paper and the above figures read from the curves.

## ACTINIUM EMANATIONS.

### SOLUBILITY IN SEVERAL SOLVENTS.

(Hevesy, 1912.)

A method was elaborated for determining the partition coefficient between a gas and a liquid phase. The solubility of actinium emanations was then determined in  $\text{KCl}$ ,  $\text{H}_2\text{O}$ ,  $\text{H}_2\text{SO}_4$ ,  $\text{C}_2\text{H}_5\text{OH}$ ,  $\text{C}_4\text{H}_{11}\text{OH}$ ,  $(\text{CH}_3)_2\text{CO}$ ,  $\text{C}_6\text{H}_5\text{CHO}$ ,  $\text{C}_6\text{H}_6$ ,  $\text{C}_7\text{H}_8$ , petroleum ether and  $\text{CS}_2$ . The solubility increases in the order named. Close relations are indicated between actinium, thorium and radium.

## ADIPIIC ACID (Normal) $(\text{CH}_2)_4(\text{COOH})_2$ .

100 grams  $\text{H}_2\text{O}$  dissolve 1.44 grams adipic acid at  $15^\circ$ .

(Henry — Compt. rend., 99, 1157, '84; Lamouroux — *Ibid.*, 128, 998, '99.)

## ADIPINIC ACID $(\text{CH}_2)_4(\text{COOH})_2$ .

100 grams of formic acid (95%  $\text{HCOOH}$ ) dissolve 4.04 grams of  $(\text{CH}_2)_4(\text{COOH})_2$  at  $18.5^\circ$ ; 100 cc. of the saturated solution contain 4.684 grams of the acid. (Aschan, 1913.)

## AGARIC ACID $\text{C}_{10}\text{H}_{20}\text{O}_6 \cdot \text{H}_2\text{O}$ .

100 grams trichloroethylene dissolve 0.014 gram agaric acid at  $15^\circ$ .

(Wester and Bruins, 1914.)



## AIR

## SOLUBILITY IN WATER.

(Winkler — Ber. 34, 1409, '01; see also Peterson and Sondern — Ber. 22, 1430, '89.)

t°.	B.	B'.	cc.* of atmospheric O and N per liter of: Dist. H <sub>2</sub> O (at 760 mm.).		Sea Water (at 760 mm.).	
			Oxygen.	Nitrogen.	Oxygen.	Nitrogen.
0	0.02881	0.02864	10.19	18.45	7.77	14.85
5	.02543	.02521	8.91	16.30	6.93	13.32
10	.02264	.02237	7.87	14.50	6.29	12.06
15	.02045	.02011	7.04	13.07	5.70	11.05
20	.01869	.01826	6.35	11.91	...	10.25
25	.01724	.01671	5.75	10.96	...	9.62
30	.01606	.01539	5.24	10.15		
40	.01418	.01315	4.48	8.67		
50	.01297	.01140	3.85	7.55		
60	.01216	.00978	3.28	6.50		
80	.01126	.00600	1.97	4.03		
100	.01105	.00000	0.00	0.00		

B = "Coefficient of Absorption," *i.e.*, the amount of gas dissolved by the liquid when the pressure of the gas itself without the tension of the liquid amounts to 760 mm.

B' = "Solubility," *i.e.*, the amount of gas, reduced to 0° and 760 mm., which is absorbed by one volume of the liquid when the barometer indicates 760 mm. pressure.

\* Reduced to 0° and 760 mm.

SOLUBILITY OF AIR IN AQUEOUS SULPHURIC ACID AT 18° AND 760 MM.  
(Tower — Z. anorg. Ch. 50, 382, '06.)

Wt. % H <sub>2</sub> SO <sub>4</sub>	98	90	80	70	60	50
Solubility Coef.	0.0173	0.0069	0.0069	0.0055	0.0059	0.0076

SOLUBILITY OF AIR IN ALCOHOL, ETC.  
(Robinet, 1864.)

Solvent.	Vols. Air per 100 Vols. Solvent.	Solvent.	Vols. Air per 100 Vols. Solvent.
Alcohol (95.1%)	14.1	Oil of Lavender.	6.9
Petroleum	6.8	Oil of Turpentine	24.2
Benzene	14.0		

**ALANINE** ( $\alpha$  Aminopropionic Acid) CH<sub>3</sub>CH(NH<sub>2</sub>)COOH.

SOLUBILITY IN MIXTURES OF ALCOHOL AND WATER AT 25°.  
(Holleman and Antusch, 1894.)

Vol. % Alcohol.	Gms. per 100 Gms. Solvent.	Sp. Gr. of Solutions.	Vol. % Alcohol.	Gms. per 100 Gms. Solvent.	Sp. Gr. of Solutions.
0	16.47	1.0421	35	4.91	0.9670
5	14.37	1.0311	40	3.89	0.9577
10	12.43	1.0280	50	2.38	0.9355
15	10.49	1.0101	60	1.57	0.9102
20	8.48	0.9984	70	0.85	0.8836
25	7.11	0.9886	80	0.37	0.8556
31	5.53	0.9761			

See remarks under  $\alpha$  Acetnaphthalide, page 13.

100 gms. pyridine dissolve 0.16 gm.  $\alpha$  alanine at 20–25°.

(Dehn, 1917.)



**ALANINE**

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**SOLUBILITY OF *d* ALANINE AND OF *dl* ALANINE IN WATER AT DIFFERENT TEMPERATURES.**

(Pellini and Coppola, 1913.)

Results for:

t°.	<i>d</i> Alanine.	<i>d - l</i> Alanine.	Mixtures <i>d + l</i> Alanine.	
	Gms. <i>d</i> Alanine per 100 Gms. H <sub>2</sub> O.	Gms. <i>d - l</i> Alanine per 100 Gms. H <sub>2</sub> O.	Gms. per 100 Gms. H <sub>2</sub> O.	
			<i>d</i> Alanine.	<i>l</i> Alanine.
0	12.99	12.89	13.27	4.01
17	15.17	14.95	14.5	4.1
30	17.39	17.72	17.05	4.99
45	20.55	21.58	...	...

**ALBUMIN** (Egg).100 gms. H<sub>2</sub>O dissolve 100 gms. egg albumin at 20-25°. (Dehn, 1917.)

100 gms. pyridine dissolve 0.1 gm. egg albumin at 20°-25°. "

100 gms. aq. 50% pyridine dissolve 6.29 gms. egg albumin at 20°-25°. (Dehn, 1917.)

**ALLANTOIN** C<sub>4</sub>H<sub>6</sub>N<sub>4</sub>O<sub>3</sub>.**SOLUBILITY IN WATER.**

(Titherly, 1912.)

The author obtained results varying from 0.7 to 0.77 gms. allantoin per 100 gms. H<sub>2</sub>O at 25°. The variations were considered to be due to slow decomposition of the compound.

**ALIZARIN** C<sub>14</sub>H<sub>8</sub>O<sub>2</sub>(OH)<sub>2</sub>.**SOLUBILITY IN WATER AT VARYING TEMPERATURES.**

(Hüttig, 1914; Beilstein.)

t°.	25°	100°.	250°.
Grams Alizarin per liter	0.000595	0.340	3.017

According to Dehn (1917), 100 gms. H<sub>2</sub>O dissolve 0.04 gm. alizarin at 20°-25°.**SOLUBILITY OF ALIZARIN IN AQUEOUS SOLUTIONS OF:**

Ammonia at 25°.		Sodium Hydroxide at 25° (Hüttig, 1914.)		
Gms. NH <sub>3</sub> per Liter.	Gms. Alizarin per Liter.	Gms. NaOH per Liter.	Gms. Alizarin per Liter.	Solid Phase.
0.160	0.132	0.427	1.159	C <sub>14</sub> H <sub>8</sub> O <sub>4</sub>
4.025	0.228	1.050	3.820	C <sub>14</sub> H <sub>8</sub> O <sub>4</sub> + C <sub>14</sub> H <sub>7</sub> O <sub>4</sub> Na

100 gms. 95% formic acid dissolve 0.10 gm. alizarin at 20.8°. (Aschan, 1913.)

Alizarin is soluble in all proportions in pyridine and in aq. 50% pyridine at 20°-25°. (Dehn, 1917.)

**ALOIN.**

Squires and Caines (1905) found the solubility of aloin in water at room temperature to be 0.83 gm. per 100 cc. and in 90% alcohol, 5.55 gms. per 100 cc.

According to Wester and Bruins (1914) 100 gms. trichloroethylene dissolve 0.013 gm. aloin at 15°.



ALUMINIUM BROMIDE  $\text{AlBr}_3$ .

## SOLUBILITY IN SEVERAL ORGANIC SOLVENTS.

(Menschutkin, 1909-10.)

(Determinations by Synthetic Method.)

In Benzene.			In Para Xylene.		
t°.	Gms. $\text{AlBr}_3$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{AlBr}_3$ per 100 Gms. Sat. Sol.	Solid Phase.
5.7 m. pt.	0	$\text{C}_6\text{H}_6$	14 m. pt.	0	$\neq \text{C}_6\text{H}_4(\text{CH}_3)_2$
4.5	10	"	12.5	11.4	"
3	20	"	10.2 Eutec.	25	$\text{AlBr}_3 + \neq \text{C}_6\text{H}_4(\text{CH}_3)_2$
1.8 Eutec.	27.4	$(\text{C}_6\text{H}_6 + \text{AlBr}_3)$	20	35.7	$\text{AlBr}_3$
10	35.3	$\text{AlBr}_3$	30	47.2	"
20	46.5	"	40	61.2	"
30	59	"	50	72.2	"
40	70	"	60	79.6	"
60	83	"	80	90.9	"
80	91.2	"	90	95.4	"
90	95.3	"	96	100	"
96	100	"			

In Toluene.			In Benzoyl Chloride.		
t°.	Gms. $\text{AlBr}_3$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{AlBr}_3$ per 100 Gms. Sat. Sol.	Solid Phase.
-15	16.1	$\text{AlBr}_3$	-0.5 m. pt.	0	$\text{C}_6\text{H}_5\text{COCl}$
0	23.7	"	-2.5	11.7	"
10	32.1	"	-5 Eutec.	22.2	$\text{C}_6\text{H}_5\text{COCl} + \text{AlBr}_3 \cdot \text{C}_6\text{H}_5\text{COCl}$
20	42.5	"	20	33.7	$\text{AlBr}_3 \cdot \text{C}_6\text{H}_5\text{COCl}$
30	56	"	40	42.6	"
40	68.8	"	60	51.6	"
50	76.5	"	80	60.5	"
70	87.2	"	90 m. pt.	65.5	"
90	95.7	"	80	68.9	"
96	100	"	60	71.8	"
			30	75.8	"
			7 Eutec.	78.8	$\text{AlBr}_3 \cdot \text{C}_6\text{H}_5\text{COCl} + \text{AlBr}_3$
			20	80.6	$\text{AlBr}_3$
			50	85.6	"
			80	93.2	"
			96	100	"

Reciprocal solubilities determined by the method of lowering of the freezing-point (see footnote, page 1) are given by Kahlukow and Sachanow (1909) for mixtures of **Aluminium Bromide** and each of the following compounds: aniline, benzene, benzonitrile, methylbenzoate, *p* bromaniline, bromobenzene, methylene bromide, *p* dibromobenzene, dimethylaniline, diphenylamine, methyl-aniline, naphthalene, nitrobenzene, *p* yridine, toluene and *p* xylene. Similar data for mixtures of **Aluminium Bromide** and dimethylpyrone are given by Plotnikow (1911).



# ALUMINIUM BROMIDE

22

## SOLUBILITY OF ALUMINIUM BROMIDE IN SEVERAL ORGANIC SOLVENTS (Con.) (Determinations by Synthetic Method.)

### In Benzophenone.

t°.	Gms. AlBr <sub>3</sub> per 100 Gm. Sat. Sol.	Solid Phase.
48 m. pt.	0	(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub> CO
45	12	"
42	19	"
38 Eutec.	24.7	" + AlBr <sub>3</sub> ·(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub> CO
60	30.9	AlBr <sub>3</sub> ·(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub> CO
80	36.4	"
100	42.2	"
120	49	"
130	53	"
142 m. pt.	59.5	"
130	64	"
100	69	"
70	72.2	"
50	74	"
38 Eutec.	75	" + AlBr <sub>3</sub>
50	78	AlBr <sub>3</sub>
80	88	"
90	93.5	"
96	100	"

### In Ethylene Bromide.<sup>1</sup>

t°.	Gms. AlBr <sub>3</sub> per 100 Gm. Sat. Sol.	Solid Phase.
10 m. pt.	0	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>
6	11.5	"
2	21.3	"
-2 Eutec.	29.7	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub> + AlBr <sub>3</sub>
10	36.1	AlBr <sub>3</sub>
20	42.1	"
30	48.7	"
40	56	"
50	63.7	"
60	71.5	"
70	79.1	"
80	86.8	"
90	94.5	"
96	100	"

### In Nitrobenzene.

t°.	Gms. AlBr <sub>3</sub> per 100 Gm. Sat. Sol.	Solid Phase.
5.5 m. pt.	0	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>
0	18	"
-5	28.8	"
-15 Eutec.	42	" + AlBr <sub>3</sub> ·C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>
0	44.3	AlBr <sub>3</sub> ·C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>
30	49.4	"
60	56.7	"
80	63.6	"
87 m. pt.	68.4	"
80	71.3	"
60	73.9	"
40	76.4	"
20 Eutec.	78.9	" + AlBr <sub>3</sub>
40	82.4	AlBr <sub>3</sub>
60	85.8	"
80	89.8	"
93	96.6	"
96	100	"

### In o Chloronitrobenzene.

t°.	Gms. AlBr <sub>3</sub> per 100 Gm. Sat. Sol.	Solid Phase.
32.5 m. pt.	0	<sup>o</sup> C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>
25	21.8	"
13.8 Eutec.	37.5	" + AlBr <sub>3</sub> · <sup>o</sup> C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>
30	43.1	AlBr <sub>3</sub> · <sup>o</sup> C <sub>6</sub> H <sub>4</sub> ClNO <sub>2</sub>
50	50.3	"
70	57.6	"
83.5 m. pt.	62.9	"
70	67	"
40	73.7	"
21 Eutec.	77.5	" + AlBr <sub>3</sub>
40	80.6	AlBr <sub>3</sub>
60	84	"
80	88.6	"
90	93.4	"
96	100	"



SOLUBILITY OF ALUMINIUM BROMIDE IN SEVERAL ORGANIC SOLVENTS (*Con.*).

(Determinations by Synthetic Method.)

In <i>m</i> Chloronitrobenzene.			In <i>p</i> Chloronitrobenzene.		
t°.	Gms. AlBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. AlBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
44.5 m. pt.	0	$m\text{-C}_6\text{H}_4\text{ClNO}_2$	83 m. pt.	0	$p\text{-C}_6\text{H}_4\text{ClNO}_2$
40	18.9	"	80	9	"
35.5 Eutec.	27.8	" + AlBr <sub>3</sub> $m\text{-C}_6\text{H}_4\text{ClNO}_2$	70	24.8	"
50	34.8	AlBr <sub>3</sub> $m\text{-C}_6\text{H}_4\text{ClNO}_2$	60 Eutec.	36.6	" + AlBr <sub>3</sub> $p\text{-C}_6\text{H}_4\text{ClNO}_2$
70	44.5	"	80	45.6	AlBr <sub>3</sub> $p\text{-C}_6\text{H}_4\text{ClNO}_2$
90	54.5	"	100	54.9	"
103.5 m. pt.	62.9	"	115 m. pt.	62.9	"
90	68.6	"	100	66.8	"
70	73.4	"	60	72.4	"
50	77.3	"	20 Eutec.	78	" + AlBr <sub>3</sub>
40 Eutec.	79.1	" + AlBr <sub>3</sub>	60	85.3	AlBr <sub>3</sub>
60	82.2	AlBr <sub>3</sub>	80	89.3	"
80	87.1	"	93	95.4	"
90	92.2	"	96	100	"
95	95.1	"			
96	100	"			

In <i>o</i> Bromonitrobenzene.			In <i>m</i> Bromonitrobenzene.		
t°.	Gms. AlBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. AlBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
38 m. pt.	0	$o\text{-C}_6\text{H}_4\text{BrNO}_2$	54 m. pt.	0	$m\text{-C}_6\text{H}_4\text{BrNO}_2$
30	19.7	"	50	11.6	"
21 Eutec.	30	" + AlBr <sub>3</sub> $o\text{-C}_6\text{H}_4\text{BrNO}_2$	45.5 Eutec.	19.5	" + AlBr <sub>3</sub> $m\text{-C}_6\text{H}_4\text{BrNO}_2$
40	37.6	AlBr <sub>3</sub> $o\text{-C}_6\text{H}_4\text{BrNO}_2$	60	25.5	AlBr <sub>3</sub> $m\text{-C}_6\text{H}_4\text{BrNO}_2$
60	45.3	"	80	34.5	"
80	53	"	110	49.5	"
88.5 m. pt.	56.9	"	122 m. pt.	56.9	"
80	59.7	"	110	61.6	"
60	64.1	"	80	69.2	"
40	68.6	"	60	74.1	"
24 Eutec.	72	" + AlBr <sub>3</sub>	42 Eutec.	78.7	" + AlBr <sub>3</sub>
40	75.5	AlBr <sub>3</sub>	60	80.3	AlBr <sub>3</sub>
60	79.8	"	80	84.9	"
80	86.3	"	93	93.6	"
93	94.5	"	96	100	"
96	100	"			



# ALUMINIUM BROMIDE

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## SOLUBILITY OF ALUMINIUM BROMIDE IN SEVERAL ORGANIC SOLVENTS (C<sub>6</sub>) (Determinations by Synthetic Method.)

In <i>p</i> Bromonitrobenzene.				In <i>p</i> Nitrotoluene.			
t°.	Gms. AlBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.		t°.	Gms. AlBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	
124.5 m. pt.	0	<i>p</i> -C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>		53.5 m. pt.	0	<i>p</i> -C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> NO <sub>2</sub>	
119	10	"		50	10	"	
110	25.2	"		40	31.3	"	
98 Eutec.	35.3	" + AlBr <sub>3</sub> <i>p</i> -C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>		29 Eutec.	46.1	" + AlBr <sub>3</sub> <i>p</i> -C <sub>6</sub> H <sub>4</sub> CH	
110	39.7	AlBr <sub>3</sub> <i>p</i> -C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>		50	52.9	AlBr <sub>3</sub> <i>p</i> -C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> N	
130	48.7	"		80	63	"	
144 m. pt.	56.9	"		88 m. pt.	66	"	
120	65.5	"		80	68.5	"	
90	70.5	"		50	74.3	"	
60	74.1	"		27 Eutec.	78.9	" + AlBr	
45 Eutec.	76	" + AlBr <sub>3</sub>		50	83.3	AlBr <sub>3</sub>	
60	79.6	AlBr <sub>3</sub>		70	87.7	"	
80	86.6	"		85	92.2	"	
93	95.4	"		93	96.7	"	
96	100	"		96	100	"	

In <i>m</i> Nitrotoluene.				In <i>o</i> Nitrotoluene.			
t°.	Gms. AlBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.		t°.	Gms. AlBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	
16 m. pt.	0	<i>m</i> -C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> NO <sub>2</sub>		— 8.5 m. pt.	0	<i>o</i> -C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> NO <sub>2</sub>	
12	14.5	"		— 11 Eutec.	8.7	" + AlBr <sub>3</sub> 2 <i>o</i> -C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub>	
8	21.8	"		10	12.8	AlBr <sub>3</sub> 2 <i>o</i> -C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> NO <sub>2</sub>	
1 Eutec.	32	" + AlBr <sub>3</sub> <i>m</i> -C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> NO <sub>2</sub>		30	24.8	"	
20	38.5	AlBr <sub>3</sub> <i>m</i> -C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> NO <sub>2</sub>		40	38	"	
40	46.6	"		42.5 Eutec.	47.7	" + AlBr <sub>3</sub> 2 <i>o</i> -C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub>	
80	59.7	"		60	54.3	AlBr <sub>3</sub> <i>o</i> -C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> NC	
90	63.3	"		75	59.5	"	
96 m. pt.	66	"		90 m. pt.	66	"	
90	68.8	"		70	72	"	
60	73.8	"		40	76.1	"	
27 Eutec.	78.9	" + AlBr <sub>3</sub>		19 Eutec.	79.1	" + AlBr <sub>3</sub>	
40	82	AlBr <sub>3</sub>		40	82.5	AlBr <sub>3</sub>	
70	89	"		70	87.5	"	
90	95.3	"		90	93.8	"	
96	100	"		96	100	"	



ALUMINIUM CHLORIDE  $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Gerlach — Z. anal. Ch. 8, 250, '69.)

100 gms. saturated solution contain 41.13 gms.  $\text{AlCl}_3$  at  $15^\circ$ , Sp. Gr. of solution = 1.354.

## SOLUBILITY OF ALUMINIUM CHLORIDE IN SEVERAL ORGANIC SOLVENTS.

(Menschutkin, 1909.)

(Determinations by Synthetic Method.)

In Nitrobenzene.			In <i>o</i> Chloronitrobenzene.		
t°.	Gms. $\text{AlCl}_3$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{AlCl}_3$ per 100 Gms. Sat. Sol.	Solid Phase.
5.5 m. pt.	0	$\text{C}_6\text{H}_5\text{NO}_2$	32.5 m. pt.	0	$\text{C}_6\text{H}_4\text{ClNO}_2$
2 Eutec.	10.3	" + $\text{AlCl}_3 \cdot 2\text{C}_6\text{H}_5\text{NO}_2$	27	10.2	"
15	18	$\text{AlCl}_3 \cdot 2\text{C}_6\text{H}_5\text{NO}_2$	21	16.1	"
25.5 Eutec.	30.5	" + $\text{AlCl}_3 \cdot \text{C}_6\text{H}_5\text{NO}_2$	15 Eutec.	20.3	" + $\text{AlCl}_3 \cdot \text{C}_6\text{H}_4\text{ClNO}_2$
45	34.2	$\text{AlCl}_3 \cdot \text{C}_6\text{H}_5\text{NO}_2$	35	25.5	$\text{AlCl}_3 \cdot \text{C}_6\text{H}_4\text{ClNO}_2$
65	39.5	"	55	31.5	"
85	48	"	75	38.7	"
90 m. pt.	52	"	89 m. pt.	45.9	"
82	55.6	"	80	51	"
72	58	"	69 Eutec.	54.4	" + $\text{AlCl}_3$
52 Eutec.	61.6	" + $\text{AlCl}_3$	110	57.5	$\text{AlCl}_3$
90	64	$\text{AlCl}_3$	150	65.4	"
130	67.7	"	175	74.6	"
160	72.4	"	194	100	"
180	80.1	"			
194	100	"			

In <i>m</i> Chloronitrobenzene.			In <i>p</i> Chloronitrobenzene.		
t°.	Gms. $\text{AlCl}_3$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{AlCl}_3$ per 100 Gms. Sat. Sol.	Solid Phase.
44.5 m. pt.	0	$\text{C}_6\text{H}_4\text{ClNO}_2$	83.5 m. pt.	0	$\text{C}_6\text{H}_4\text{ClNO}_2$
44	10.7	"	78	7.1	"
36 Eutec.	16.6	" + $\text{AlCl}_3 \cdot m\text{C}_6\text{H}_4\text{ClNO}_2$	73	12.8	"
50	21	$\text{AlCl}_3 \cdot m\text{C}_6\text{H}_4\text{ClNO}_2$	68 Eutec.	17.1	" + $\text{AlCl}_3 \cdot p\text{C}_6\text{H}_4\text{ClNO}_2$
70	28.3	"	80	22.2	$\text{AlCl}_3 \cdot p\text{C}_6\text{H}_4\text{ClNO}_2$
90	36.8	"	100	31.4	"
104 m. pt.	45.9	"	120	41.8	"
90	52.4	"	126 m. pt.	45.9	"
81 Eutec.	55.6	" + $\text{AlCl}_3$	110	53.2	"
120	60	$\text{AlCl}_3$	94 Eutec.	58.1	" + $\text{AlCl}_3$
140	64.1	"	125	60.5	$\text{AlCl}_3$
160	70.2	"	155	66.9	"
			180	77.7	"
			190	88.2	"
			194	100	"

The solubility of aluminium chloride in anhydrous hydrazine is stated by Welsh and Broderon (1915) to be 1.0 gm. in 100 cc. at room temperature.



## SOLUBILITY IN SEVERAL ORGANIC SOLVENTS (Con.).

(Determinations by Synthetic Method.)

In <i>o</i> Bromonitrobenzene.			In <i>m</i> Bromonitrobenzene.		
t°.	Gms. AlCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. AlCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
38.5	0	<i>o</i> C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	54.7	0	<i>m</i> C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>
32	7.5	"	51	6.5	"
26	13.1	"	47 Eutec.	11.9	" + AlCl <sub>3</sub> · <i>m</i> C <sub>6</sub> H <sub>4</sub> Br
20 Eutec.	17.5	" + AlCl <sub>3</sub> · <i>o</i> C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	60	16	AlCl <sub>3</sub> · <i>m</i> C <sub>6</sub> H <sub>4</sub> Br
40	21.7	AlCl <sub>3</sub> · <i>o</i> C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	80	22.9	"
60	26.4	"	100	30.7	"
80	31.7	"	110	35.9	"
97 m. pt.	38	"	116 m. pt.	39.8	"
100	39.8	"	113	42.3	"
90	44.6	"	107	44.5	"
80 Eutec.	46.5	" + AlCl <sub>3</sub>	97 Eutec.	47.4	" + AlCl <sub>3</sub>
110	50.1	AlCl <sub>3</sub>	120	51.5	AlCl <sub>3</sub>
130	54.1	"	140	56.5	"
150	60.2	"	160	64.5	"
170	70	"	180	77.4	"
180	77.4	"	190	88.8	"
			197	100	"

In <i>p</i> Bromonitrobenzene.			In <i>o</i> Nitrotoluene.		
t°.	Gms. AlCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. AlCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
124.5 m. pt.	0	<i>p</i> C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	-8.5 m. pt.	0	<i>o</i> C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> NO <sub>2</sub>
117	7.4	"	-9.3 Eutec.	1	" + AlCl <sub>3</sub> ·2 <i>o</i> C <sub>6</sub> H <sub>4</sub> Cl
111	12.8	"	0	1.5	AlCl <sub>3</sub> ·2 <i>o</i> C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> NO
105	17.7	"	20	4	"
99 Eutec.	22.2	" + AlCl <sub>3</sub> · <i>p</i> C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	40	11	"
120	28.4	AlCl <sub>3</sub> · <i>p</i> C <sub>6</sub> H <sub>4</sub> BrNO <sub>2</sub>	55 Eutec.	31	" + AlCl <sub>3</sub> · <i>o</i> C <sub>6</sub> H <sub>4</sub> Cl
140	36.4	"	85	41.8	AlCl <sub>3</sub> · <i>o</i> C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> N
145 m. pt.	39.8	"	95.5 m. pt.	49.3	"
140	44.5	"	70	56.8	"
120	51.2	"	45 Eutec.	61.5	" + AlCl <sub>3</sub>
113 Eutec.	52.8	" + AlCl <sub>3</sub>	95	64.5	AlCl <sub>3</sub>
130	55.9	AlCl <sub>3</sub>	145	73.7	"
150	61.3	"	180	86.2	"
180	77.4	"	185	89.5	"
190	88.8	"	194	100	"
194	100.0	"			

One liter sat. solution of AlCl<sub>3</sub> in CCl<sub>4</sub> contains 0.74 gm. at 4°, 0.22 gm. at 15°, 0.15 gm. at 20° and 0.06 gm. at 34°.

One liter sat. solution of AlCl<sub>3</sub> in CHCl<sub>3</sub> contains 0.65 gm. at -15°, 1.0 gm. at 0° and 0.72 gm. at 25°.

(Lloyd,



SOLUBILITY IN SEVERAL ORGANIC SOLVENTS (Con.).  
(Determinations by Synthetic Method.)

In <i>m</i> Nitrotoluene.			In <i>p</i> Nitrotoluene.		
t°.	Gms. AlCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. AlCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
16 m. pt.	0	$\equiv$ C <sub>6</sub> H <sub>4</sub> CH <sub>2</sub> NO <sub>2</sub>	52.5 m. pt.	0	$\neq$ C <sub>6</sub> H <sub>4</sub> CH <sub>2</sub> NO <sub>2</sub>
13 Eutec.	7.8	" + AlCl <sub>3</sub> $\equiv$ C <sub>6</sub> H <sub>4</sub> CH <sub>2</sub> NO <sub>2</sub>	47	9.2	"
27	13.4	AlCl <sub>3</sub> $\equiv$ C <sub>6</sub> H <sub>4</sub> CH <sub>2</sub> NO <sub>2</sub>	42	15	"
35 Eutec.	24.5	" + AlCl <sub>3</sub> $\equiv$ C <sub>6</sub> H <sub>4</sub> CH <sub>2</sub> NO <sub>2</sub>	37 Eutec.	19	" + AlCl <sub>3</sub> $\neq$ C <sub>6</sub> H <sub>4</sub> CH <sub>2</sub> NO <sub>2</sub>
65	34	AlCl <sub>3</sub> $\equiv$ C <sub>6</sub> H <sub>4</sub> CH <sub>2</sub> NO <sub>2</sub>	55	29.1	AlCl <sub>3</sub> $\neq$ C <sub>6</sub> H <sub>4</sub> CH <sub>2</sub> NO <sub>2</sub>
90	44.2	"	80	34.8	"
95	46.7	"	95	41.3	"
99.5 m. pt.	49.3	"	109 m. pt.	49.3	"
70	56.8	"	100	53.4	"
45 Eutec.	61.5	" + AlCl <sub>3</sub>	60	61.7	"
95	64.5	AlCl <sub>3</sub>	45 Eutec.	64	" + AlCl <sub>3</sub>
120	68.2	"	105	69.5	AlCl <sub>3</sub>
130	70.2	"	165	80	"
			190	94.3	"
			194	100.0	"

In Benzophenone.			In Benzoyl Chloride.		
t°.	Gms. AlCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. AlCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
48 m. pt.	0	(C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub> CO	-0.5 m. pt.	0	C <sub>6</sub> H <sub>5</sub> COCl
44	8.5	"	-4	7.9	"
39.5 Eutec.	15.4	" + AlCl <sub>3</sub> (C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub> CO	-7.5 Eutec.	12.7	" + AlCl <sub>3</sub> C <sub>6</sub> H <sub>5</sub> COCl
60	19.3	AlCl <sub>3</sub> (C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub> CO	0	14.1	AlCl <sub>3</sub> C <sub>6</sub> H <sub>5</sub> COCl
90	26.5	"	20	18.8	"
120	37	"	40	25	"
130 m. pt.	42.3	"	60	33	"
110	48.8	"	80	42.2	"
80	53.5	"	93 m. pt.	48.7	"
60 Eutec.	56.1	" + AlCl <sub>3</sub>	80	52.9	"
100	58	AlCl <sub>3</sub>	60	57.2	"
140	63	"	40	61	"
160	68.6	"			
180	78.5	"			
190	89.1	"			
192	93	"			
194	100	"			

ALUMINIUM FLUORIDE AlF<sub>3</sub>.

Fusion-point data (Solubility, see footnote, page 1) are given by Pushin and Baskov (1913) for the following mixtures:

AlF<sub>3</sub> + NaF, AlF<sub>3</sub> + KF, AlF<sub>3</sub> + LiF, AlF<sub>3</sub> + CsF, AlF<sub>3</sub> + RbF.

Similar data for mixtures of AlF<sub>3</sub> + NaF are given by Fedotieff and Illjinsky (1913).



## ALUMINIUM HYDROXIDE 28

### ALUMINIUM HYDROXIDE $\text{Al}(\text{OH})_3$ .

SOLUBILITY OF MOIST FRESHLY PRECIPITATED ALUMINIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF ALUMINIUM SULPHATE.

(Kremann and Hüttinger, 1908.)

Results at 20°.			Results at 40°.		
Gms. per 100 $\text{Al}_2(\text{SO}_4)_3$	Gms. $\text{H}_2\text{O}$ . $\text{Al}(\text{OH})_3$	Solid Phase.	Gms. per 100 $\text{Al}_2(\text{SO}_4)_3$	Gms. $\text{H}_2\text{O}$ . $\text{Al}(\text{OH})_3$	Solid Phase.
2.37	0.15	$\text{Al}_2\text{O}_3 \cdot \text{SO}_3 \cdot 9\text{H}_2\text{O}$	5.22	1.33	$\text{Al}_2\text{O}_3 \cdot \text{SO}_3 \cdot 9\text{H}_2\text{O}$
5	0.30	"	...	...	Transition Point
7	0.65	"	8.85	1.82	$\text{Al}_2\text{O}_3 \cdot 2\text{SO}_3 \cdot 12\text{H}_2\text{O}$
9.1	1.30	Transition Point	10	1.65	"
10	1.23	$\text{Al}_2\text{O}_3 \cdot 2\text{SO}_3 \cdot 12\text{H}_2\text{O}$	15	1.40	"
15	1.04	"	20	2.15	"
20	1.40	"	25	3.80	"
25	2.40	"	28.5	5.80	Transition Point
30	3.70	"	30	4.35	$\text{Al}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 16\text{H}_2\text{O}$
31.6	4.20	Transition Point	35	1.60	"
33	2.75	$\text{Al}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 16\text{H}_2\text{O}$	49	0.60	"
34.73	0.92	"			

\* The figures given are not sufficient to determine this transition point accurately.

† The author's figures for 60° are reproduced without change as they are not sufficient to determine transition points.

Results at 60°.		
Gms. per 100 $\text{Al}_2(\text{SO}_4)_3$	Gms. $\text{H}_2\text{O}$ . $\text{Al}(\text{OH})_3$	Solid Phase.
3.24	0.75	$\text{Al}_2\text{O}_3 \cdot \text{SO}_3 \cdot 9\text{H}_2\text{O}$
8.83	2.53	$\text{Al}_2\text{O}_3 \cdot 2\text{SO}_3 \cdot 12\text{H}_2\text{O}$
12.67	1.85	"
24.07	3.14	"
31.55	4.89	"
42.38	6.02	$\text{Al}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 16\text{H}_2\text{O}$
49.85	1.42	"

### SOLUBILITY OF ALUMINIUM HYDROXIDE IN AQUEOUS SODIUM HYDROXIDE SOLUTIONS. (Haber and van Oordt, 1904.)

The mixtures were agitated for 24 hours. So-called acetic acid soluble tonerde (E. Merck) was used for the experiments. Temp. 20°–23°.

Normality of Aq. NaOH.	Gms. $\text{Al}_2\text{O}_3$ per Liter.
0.49	9.27
0.99	13.90
2.00	14.40

### SOLUBILITY OF ALUMINIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF SODIUM HYDROXIDE. (Herz, 1911; Slade, 1911 and 1912.)

The experiments show that the ratio of Na to Al in the solution varies considerably depending upon whether the used Al hydroxide was precipitated hot or cold, also upon the length of time it was dried and upon the nature of the drying agent. Herz found a nearly constant ratio of 3 Na to 1 Al in solution. Slade gives ratios of approximately 2.5 : 1 in normal NaOH at 25° for cold precipitated hydroxide dried over  $\text{H}_2\text{SO}_4$  and 9.0 : 1 for hot precipitated Al hydroxide dried over  $\text{P}_2\text{O}_5$ . Drying in thin layers also increased this ratio but to a somewhat less extent. Slade reports the solubility of  $\text{Al}(\text{OH})_3$  in a 0.6414 normal NaOH solution to be 1.34 gm. per 100 cc. at room temperature.

### ALUMINIUM OXIDE $\text{Al}_2\text{O}_3$ .

Fusion-point lowering data for mixtures of aluminium oxide and cryolite are given by Lorenz, Jabs and Eitel (1913). The results show one eutectic at approximately 940°. The eutectic mixture contains 19.8%  $\text{Al}_2\text{O}_3$ .

Results for aluminium oxide and magnesium oxide are given by Rankin and Merwin (1916).



ALUMINIUM SULFATE  $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Poggiale, 1843; Kremann and Hüttinger, 1908.)

t°.	Gms. $\text{Al}_2(\text{SO}_4)_3$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{Al}_2(\text{SO}_4)_3$ per 100 Gms. Sat. Sol.	Solid Phase.
- 1.02	8.09	Ice	20	26.7	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
- 1.43	10.7	"	30	28.8	"
- 2.04	14.3	"	40	31.4	"
- 2.65	17.5	"	50	34.3	"
- 2.85	19.2	"	60	37.2	"
- 4 Eutec.	23.1	Ice + $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$	70	39.8	"
0	23.8	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$	80	42.2	"
+ 7.73	24.8	"	90	44.7	"
10	25.1	"	100	47.1	"

## SOLUBILITY OF ALUMINIUM SULFATE IN AQUEOUS SOLUTIONS OF FERRIC SULFATE AT 25° AND VICE VERSA. (Wirth and Bakke, 1914.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{Al}_2(\text{SO}_4)_3$	$\text{Fe}_2(\text{SO}_4)_3$		$\text{Al}_2(\text{SO}_4)_3$	$\text{Fe}_2(\text{SO}_4)_3$	
27.82	0	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$	10.03	32.42	$\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$
26.01	6.064	"	8.819	34.02	"
24.21	9.819	"	6.626	35.82	"
21.64	13.02	"	5.200	38.83	"
15.22	23.28	"	2.342	42.44	"
10.46	31.90	" + $\text{Fe}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$	...	44.97	"

## EQUILIBRIUM BETWEEN ALUMINIUM SULFATE, LITHIUM SULFATE, AND WATER AT 30°. (Schreinemaker and De Waal, 1906.)

Composition in Weight per cent:

Of Solution.		Of Residue.		Solid Phase.
% $\text{Li}_2\text{SO}_4$ .	% $\text{Al}_2(\text{SO}_4)_3$ .	% $\text{Li}_2\text{SO}_4$ .	% $\text{Al}_2(\text{SO}_4)_3$ .	
25.1	0	...	...	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
21.93	5.34	...	...	"
16.10	14.89	63.70	4.02	"
13.63	20.76	14.72	31.17	{ $\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ + $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
13.24	21.71	61.24	7.22	
11.73	22.08	6.92	33.54	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
6.75	24.34	3.77	37.06	"
3.44	26.12	...	...	"
0.0	28.0	...	...	"

## SOLUBILITY OF ALUMINIUM SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 25°. (Wirth, 1912.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{Al}_2(\text{SO}_4)_3$	$\text{H}_2\text{SO}_4$		$\text{Al}_2(\text{SO}_4)_3$	$\text{H}_2\text{SO}_4$	
27.82	0	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$	4.8	40	$\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$
29.21	5.13	"	1.5	50	"
26.2	10	"	1	60	"
19.5	20	"	2.3	70	"
11.6	30	"	4	75	"

A curve was plotted from the published results and the above figures read from the curve.

100 gms. glycol dissolve 16.82 gms.  $\text{Al}_2(\text{SO}_4)_3$ .

(de Coninck, 1905.)

ALUMINIUM SULFIDE  $\text{Al}_2\text{S}_3$ .

Fusion-point data for mixtures of  $\text{Al}_2\text{S}_3$  +  $\text{Ag}_2\text{S}$  are given by Cambi (1912).



### SOLUBILITY OF AMMONIUM ALUM AND OF POTASSIUM ALUM IN WATER.

(Mulder; Poggiale — Ann. chim. phys. [3] 8, 467, '43; Locke — Am. Ch. J. 26, 174, '01; Marino — Gazz. chim. ital. 35, II, 351, '05; Berkeley — Trans. Roy. Soc. 203 A, 214, '04.)

t°.	Ammonium Alum.			Potassium Alum.		
	Gms. (NH <sub>4</sub> ) <sub>2</sub> Al <sub>2</sub> (SO <sub>4</sub> ) <sub>6</sub> per 100 g. H <sub>2</sub> O.	Gms. (NH <sub>4</sub> ) <sub>2</sub> Al <sub>2</sub> (SO <sub>4</sub> ) <sub>6</sub> ·24H <sub>2</sub> O per 100 g. H <sub>2</sub> O.	G.M. (NH <sub>4</sub> ) <sub>2</sub> Al <sub>2</sub> (SO <sub>4</sub> ) <sub>6</sub> per 100 g. H <sub>2</sub> O.	Gms. K <sub>2</sub> Al <sub>2</sub> (SO <sub>4</sub> ) <sub>6</sub> per 100 g. H <sub>2</sub> O.	Gms. K <sub>2</sub> Al <sub>2</sub> (SO <sub>4</sub> ) <sub>6</sub> ·24H <sub>2</sub> O per 100 g. H <sub>2</sub> O.	G. M. K <sub>2</sub> Al <sub>2</sub> (SO <sub>4</sub> ) <sub>6</sub> per 100 g. H <sub>2</sub> O.
0	2.10	3.90	0.0044	3.0	5.65	0.0058
5	3.50	6.91	0.0074	3.5	6.62	0.0068
10	4.99	9.52	0.0105	4.0	7.60	0.0077
15	6.25	12.66	0.0132	5.0	9.59	0.0097
20	7.74	15.13	0.0163	5.9	11.40	0.0114
25	9.19	19.19	0.0194	7.23	14.14	0.0140
30	10.94	22.01	0.0231	8.39	16.58	0.0162
40	14.88	30.92	0.0314	11.70	23.83	0.0227
50	20.10	44.10	0.0424	17.00	36.40	0.0329
60	26.70	66.65	0.0569	24.75	57.35	0.0479
70	...	...	...	40.0	110.5	0.0774
80	...	...	...	71.0	321.3	0.1374
90	...	...	...	109.0	2275.0	0.2110
92.5	...	...	...	119.0	∞.	0.2313
95	109.7	∞	0.2312	...	...	...

NOTE. — The potassium alum figures in the preceding table were taken from a curve plotted from the closely agreeing determinations of Mulder, Locke, Berkeley, and Marino. For the higher temperatures (above 60°), however, the results of Marino are lower than those of the other investigators, and are omitted from the average curve.

Locke called attention in his paper to the fact that Poggiale's results upon ammonium and potassium alum had evidently become interchanged through some mistake. This explanation is entirely substantiated, not only by Locke's determinations, but also by those of Mulder and Berkeley. The ammonium alum figures given above were therefore read from Poggiale's potassium alum curve, with which Locke's determination of the solubility of ammonium alum at 25° is in entire harmony.

### SOLUBILITY OF AMMONIUM ALUM IN PRESENCE OF AMMONIUM SULFATE AND IN PRESENCE OF ALUMINIUM SULFATE IN WATER.

(Rüchhoff — Ber. 18, 1160, '85.)

Mixture Used.	100 Gms. Saturated Solution Contain:	
	Grams (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> + Grams Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	
Saturated Ammonium Alum at 18.5° . . . . .	1.42	3.69
20 cc. above sol. + 6 gms. cryst. Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> . . .	0.45	16.09
20 cc. above sol. + 4 gms. cryst. (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> . . .	20.81	0.29



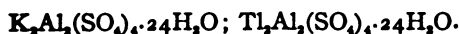
SOLUBILITY OF MIXTURES OF POTASSIUM ALUM AND ALUMINIUM SULFATE  
AND OF POTASSIUM ALUM AND POTASSIUM SULFATE IN WATER.

(Marino — Gazz. chim. ital. 35, II, 351, '05.)

°.	Gms. per 1000 Gms. H <sub>2</sub> O.		Gm. Mols. per 1000 Mols. H <sub>2</sub> O.		Solid Phase.
	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·18H <sub>2</sub> O.	K <sub>2</sub> SO <sub>4</sub> .	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·18H <sub>2</sub> O.	K <sub>2</sub> SO <sub>4</sub> .	
0	243.73	23.45	6.1	2.3	K <sub>2</sub> Al <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·24H <sub>2</sub> O
20	824.25	30.85	15.1	3.1	+ Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>
35	911.02	35.29	24.1	3.6	"
50	1243.21	59.55	33.5	6.1	"
65	1598.00	119.43	43.1	12.6	"
77	1872.11	183.80	50.5	18.9	"
0	5.06	75.83	0.1	7.8	K <sub>2</sub> Al <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·24H <sub>2</sub> O
0.5	8.66	75.18	0.2	7.7	+ K <sub>2</sub> SO <sub>4</sub>
5.	16.07	85.78	0.4	8.8	"
10	18.52	96.50	0.5	9.9	"
15	20.56	109.30	0.55	11.2	"
30	39.60	147.8	1.0	15.2	"
40	73.88	163.1	1.9	16.8	"
50	126.0	195.4	3.4	20.1	"
60	249.7	238.8	6.7	24.6	"
70	529.0	323.7	14.2	32.6	"
80	1044.0	517.27	28.1	53.4	"

SOLUBILITY OF MIXTURES OF POTASSIUM ALUM AND OF THALLIUM  
ALUM IN WATER AT 25°.

(Fock — Z. Kryst. Min. 28, 397, '97.)



Composition of Solution.						Solid Phase Mol. % of Potassium Alum.
KAl(SO <sub>4</sub> ) <sub>2</sub> per Liter.		TlAl(SO <sub>4</sub> ) <sub>2</sub> per Liter.		Mol. % KAl(SO <sub>4</sub> ) <sub>2</sub> .	Sp. Gr. of Solutions.	
Grams.	Mg. Mols.	Grams.	Mg. Mols.			
69.90	270.5	0.00	0.00	100	1.0591	100.0
74.56	288.2	0.48	1.13	99.61	1.0601	99.32
67.90	262.8	1.72	4.07	98.48	1.0598	96.84
65.30	252.7	4.52	10.67	95.95	1.0603	90.84
64.95	251.4	9.60	22.67	91.73	1.0605	82.94
53.23	205.9	18.44	43.56	82.54	1.0609	68.24
45.32	175.4	24.60	58.10	75.12	1.0609	58.23
38.02	147.2	32.48	76.75	65.73	1.0611	46.72
34.54	133.6	35.59	84.10	61.36	1.0611	44.23
28.35	109.7	42.99	101.60	51.93	1.0623	32.07
10.94	42.4	66.12	156.2	21.34	1.0654	7.94
0.00	0.0	75.46	178.3	0.00	1.0674	0.00

Data for the influence of pressure on the solubility of potassium alum in water at 0° are given by Stackelberg, 1896.

Data for the solubility of Rubidium Alums are given on p. 582.



## SOLUBILITY OF SODIUM ALUM IN WATER.

(Smith, 1909.)

t°.	Gms. $\text{Na}_2\text{Al}_2(\text{SO}_4)_4$ per 100 Gms.		t°.	Gms. $\text{Na}_2\text{Al}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$ per	
	Sat. Sol.	Water.		Sat. Sol.	Wa
10	26.9	36.7	10	50.8	10.
15	27.9	38.7	15	52.7	11.
20	29	40.9	20	54.8	12.
25	30.1	43.1	25	56.9	13.
30	31.4	45.8	30	59.4	14.

Above 30°, sodium alum is decomposed in contact with its saturated solution. The exact temperature of transition has not been determined.

Single determinations differing from the above are given by Tilden and by Auge (1890).

## SOLUBILITY OF CAESIUM ALUM, RUBIDIUM ALUM, AND OF THALLIUM ALUM IN WATER.

(Setterburg—Liebig's Annalen, 211, 104, '82; Locke—Am. Ch. J. 26, 183, '01; Berkeley Roy. Soc. 203 A, 215, '04.)

t°.	Caesium Alum.		Rubidium Alum.		Thallium Alum	
	Gms. per 100 Gms. $\text{H}_2\text{O}$ .		Gms. per 100 Gms. $\text{H}_2\text{O}$ .		Gms. per 100 Gms.	
	$\text{Al}_2\text{Cs}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$	$\text{Al}_2\text{Cs}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$	$\text{Al}_2\text{Rb}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$	$\text{Al}_2\text{Rb}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$	$\text{Al}_2\text{Th}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$	$\text{Al}_2\text{Th}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$
0	0.21	0.34	0.72	1.21	3.15	
5	0.25	0.40	0.86	1.48	3.80	
10	0.30	0.49	1.05	1.81	4.60	
20	0.40	0.65	1.50	2.59	6.40	1
25	0.50	0.81	1.80	3.12	7.60	1
30	0.60	0.97	2.20	3.82	9.38	1
40	0.85	1.38	3.25	5.69	14.40	2
50	1.30	2.11	4.80	8.50	22.50	3
60	2.00	3.27	7.40	13.36	35.36	6
70	3.20	5.27	12.40	23.25	...	
80	5.40	9.01	21.60	43.25	...	
90	10.50	18.11	...	...	...	
100	22.70	42.54	...	...	...	

NOTE.—Curves were plotted from the closely agreeing determinations recorded by the above named investigators and the tabulated values were constructed from the curves.

Recent determinations of the solubility of caesium alum in water, by Huselton (1914), agree well with the data in the above table. For additional caesium alums see page 180.

## SOLUBILITY OF Ammonium Chromium Alum IN WATER.

(Koppel, 1906.)

It was shown that, due to the transition between the violet and green forms of the compound, the saturation point is reached very slowly, especially at higher temperatures. From the determinations at 0° it was found that equilibrium is reached in 2½ hours. If this saturation time is taken for the other temperatures, the results are considered to show the solubility of the violet form alone. The final saturation represents the attainment of an equilibrium between the violet and green forms.

Results for the Violet Form.			Results for Final Equilibrium		
t°.	Time of Saturation, Hrs.	Gms. $(\text{NH}_4)_2\text{Cr}(\text{SO}_4)_2$ per 100 Gms. Sol.	t°.	Time of Saturation, Hrs.	Gms. $(\text{NH}_4)_2\text{Cr}(\text{SO}_4)_2$ per 100 Gms.
0	2.5	3.8	0	2.5	3.8
30	2.5	10.6	30	300	15.7
40	2.5	15.5	40	250	24.5



AMMONIA  $\text{NH}_3$ .

## SOLUBILITY OF AMMONIA IN WATER.

(Dumas and Dittmar—Liebig's Annalen, 112, 334, '50; Raoult—Ann. chim. [5] 1, 262, '74; Mallet—Am. Ch. J. 19, 807, '97.)

t°.	At 760 mm. Pressure.		t°.	At 760 mm. Pressure.	
	G. $\text{NH}_3$ per 100 g. $\text{H}_2\text{O}$ .	Vol. $\text{NH}_3$ per 1 g. $\text{H}_2\text{O}$ .		G. $\text{NH}_3$ per 100 g. $\text{H}_2\text{O}$ .	Vol. $\text{NH}_3$ per 1 g. $\text{H}_2\text{O}$ .
-40	294.6	...	20	52.6	710
-30	278.1	...	25	46.0	635
-20	176.8	...	30	40.3	595 (28°)
-10	111.5	...	35	35.5	...
0	87.5	1299	40	30.7	...
5	77.5	1019	45	27.0	...
10	67.9	910	50	22.9	...
15	60.0	802	55	18.5	...

## SOLUBILITY OF AMMONIA IN WATER DETERMINED BY METHOD OF LOWERING OF FREEZING-POINT.

(Rupert, 1910.)

t°	Gms. $\text{NH}_3$ per 100 Gms. Sol.	Solid Phase.	t°	Gms. $\text{NH}_3$ per 100 Gms. Sol.	Solid Phase.
0	0	Ice	-80.6	52	$\text{NH}_3\text{H}_2\text{O}$
-2	2	"	-82.8	54	"
-4.6	4	"	-85.8	56	"
-7.6	6	"	-87	Eutec. 56.5	$\text{NH}_3\text{H}_2\text{O} + 2\text{NH}_3\text{H}_2\text{O}$
-10.6	8	"	-84.8	58	$2\text{NH}_3\text{H}_2\text{O}$
-13.9	10	"	-82.2	60	"
-17.6	12	"	-80.4	62	"
-21.4	14	"	-79.2	64	"
-25.8	16	"	-79.8 m. pt.	66	"
-31.3	18	"	-79.2	68	"
-37	20	"	-80.3	70	"
-43.6	22	"	-82.1	72	"
-50.7	24	"	-84.5	74	"
-60.3	26	"	-87.4	76	"
-72.2	28	"	-90.4	78	"
-87.2	30	"	-93.6	80	"
-102.3	32	"	-94	Eutec. 80.3	$2\text{NH}_3\text{H}_2\text{O} + \text{NH}_3$
-116.7	34	"	-91.7	82	$\text{NH}_3$
-120	Eutec. 34.5	Ice + $\text{NH}_3\text{H}_2\text{O}$	-89.4	84	"
-103.8	36	$\text{NH}_3\text{H}_2\text{O}$	-87.4	86	"
-92.9	38	"	-85.6	88	"
-86.7	40	"	-84.1	90	"
-83.5	42	"	-82.7	92	"
-81.4	44	"	-81.5	94	"
-80	46	"	-80.3	96	"
-79.3	48.7	"	-79.1	98	"
-79.4	50	"	-78	100	"

More recent data on the above system, by Smits and Postma (1914) agree quite closely with the above except in the region of the eutectic Ice +  $\text{NH}_3\text{H}_2\text{O}$ . These authors report a temperature of -100.3 instead of -120 for this point. Additional determinations are also given by Baumé and Tykociner (1914). Older data for the ice curve are given by Guthrie (1884) and Pickering (1893).



VAPOR PRESSURE OF AQUEOUS AMMONIA SOLUTIONS.  
(Perman, 1903.)

Gms. NH <sub>3</sub> per 100 Gms. Sol.	Vapor Pressure in mm. of Mercury at:					
	0°.	10°.	20°.	30°.	40°.	50°.
0	4.5	9	17.5	31.5	55	125
2.5	13	18	32.5	56.5	91	146
5	20	27	47.5	83	134.5	210
7.5	27.5	40	70	115	183.5	281
10	35	54	93	153.5	241.5	363.5
12.5	45	69	118	193.5	303.5	455
15	57.5	89	151	245	377.5	564
17.5	75	115	191	305.5	465.5	688.5
20	93	144	237	393	569.5	834.5
22.5	117	180.5	291	455.5	690	1005
25	144.5	226.5	360	561.5	830.5	1195
27.5	181	280	440	680	1007	...
30	222	346	537	817	1189.5	...

The apparatus (Perman, 1901) used for the above determinations, consisted of a pipet provided with a stop-cock at its upper end and connected with a leveling tube at its lower end. For maintaining constant temperature the vessel was surrounded by a glass jacket into which water or vapors of ammonia were boiling at various temperatures could be introduced. The aqueous ammonia solution was drawn in above the Hg and boiled to expel air. A portion was withdrawn for analysis through the stop-cock at the top, by elevating the level of Hg. The vapor pressures of the analyzed mixture at various temperatures were then read with the aid of an adjacent millimeter scale. The results were plotted from the results and readings for regular intervals of concentration and temperature made.

By means of a modification of the above apparatus the author was able to estimate the partial pressure of the ammonia and of the water of each solution. Tables for these values are given. Data have also been calculated for the latent heat of evaporation of aqueous ammonia solutions.

INFLUENCE OF SALTS AND OTHER COMPOUNDS ON THE VAPOR PRESSURE OF  
AQUEOUS AMMONIA SOLUTIONS.

(E. G. Perman, J. Chem. Soc. (Lond.), 81, 480, 1902.)

Vapor pressure determinations were made as above described on solutions of the following compositions — (a) 10.43% Urea + 16.36% K<sub>2</sub>SO<sub>4</sub>, (b) 5.29% Urea + 17.22% NH<sub>3</sub>, (c) 4.56% Mannitol + 12.27% NH<sub>3</sub>, (d) 5.27% NH<sub>4</sub>Cl + 16.85% NH<sub>3</sub>, (e) 10.26% CuSO<sub>4</sub> + 12.9% NH<sub>3</sub>, (f) 2.68% CuSO<sub>4</sub> + 14.65% NH<sub>3</sub>, (g) 3.94% CuSO<sub>4</sub> + 12.9% NH<sub>3</sub>.

The author's data were plotted on cross section paper and the following values were read from the curves.

t°.	Vapor Pressure of Each Solution in mm. of Mercury.						
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
20	204	200	120	...	193	130	155
30	325	325	198	...	302	220	235
40	485	500	311	200	471	345	365
50	715	727	465	304	695	522	545
60	1050	1060	705	453	975	770	...

In an earlier paper Perman (1901) gives data similar to the above for the vapor pressure of ammonia in aqueous solutions of sodium sulfate.



# MUTUAL SOLUBILITY OF AQUEOUS AMMONIA AND POTASSIUM CARBONATE SOLUTIONS.

(Newth — J. Chem. Soc. 77, 776, 1900.)

The solutions used were: Potassium Carbonate saturated at 15° (contained 57.2 grams  $K_2CO_3$  per 100 cc.). Aqueous Ammonia of 0.885 Sp. Gr. (contained about 33 per cent ammonia). The determinations were made by adding successive small quantities of one of the solutions to a measured volume of the other, and observing the point at which opalescence appeared.

t°.	Saturated $K_2CO_3$ in Aq. Ammonia.		Aq. Ammonia in Saturated $K_2CO_3$ .	
	cc. $K_2CO_3$ per 100 cc. Ammonia.	% $K_2CO_3$ Solution in Mixture.	cc. Ammonia in 100 cc. $K_2CO_3$ .	% $K_2CO_3$ Solution in Mixture.
1	2.0	2.0	37.5	72.7
6	3.0	3.0	47.5	67.6
11	5.0	4.7	52.5	65.0
16	6.5	6.1	60.0	63.0
21	8.5	8.0	77.5	56.3
26	10.5	9.5	105.0	49.0
31	12.5	11.1	152.5	39.0
38	20.0	16.6	195.0	33.0
39	21.0	17.0	220.0	31.0
42	25.0	20.0	250.0	28.5
43	35.0	26.0	285.0	26.5

Above 43° the solutions are completely miscible. If 10 per cent of water is added to each solution the temperature of complete miscibility is lowered to 25°. The mutual solubilities are:

t°.	Per cent $K_2CO_3$ Solution in:	
	Ammonia Layer.	$K_2CO_3$ Sol. Layer.
0	8	62
10	11	52
20	15	38
25 (crit. pt.)		25

With the addition of 12.9 per cent of water to each solution the temperature of complete miscibility (crit. pt.) is lowered to 10°. With the addition of 18.1 per cent water this temperature becomes 0°.

# SOLUBILITY OF AMMONIA IN AQUEOUS SALT SOLUTIONS.

(Raoult.)

t°.	In Calcium Nitrate Solutions		In Potassium Hydroxide Solutions	
	Gms. $NH_3$ per 100 Gms. Solvent in:		Gms. $NH_3$ per 100 Gms. Solvent in:	
	28.38% $Ca(NO_3)_2$ .	In 50.03% $Ca(NO_3)_2$ .	11.25% KOH.	25.25% KOH.
0	96.25	104.5	72.0	49.5
8	78.50	84.75	57.0	37.5
16	65.00	70.5	46.0	28.5
24	...	...	37.3	21.8

The freezing-point curve for mixtures of ammonia and ammonium thiocyanate is given by Bradley and Alexander (1912).



## SOLUBILITY OF AMMONIA IN AQUEOUS SALT SOLUTIONS AT 25°.

(Abegg and Riesenfeld, 1902.)

The determinations were made by the dynamic method of vapor pressure measurement previously used by Doyer (1890), Konowalow (1898), Gahl and Gaus (1900). It consists in passing an indifferent gas through an ammonia solution of known concentration and calculating the vapor pressure from the volume of indifferent gas required to remove a definite amount of ammonia from solution. The indifferent gas ( $H + O$ ) was generated by electric current and its volume measured by means of a voltmeter. The accompanying ammonia was removed by passing through 0.01 n. HCl and estimated by means of electrolytic conductivity. The molecular vapor pressure was obtained by dividing the absolute vapor pressure, calculated from above measurements, by the concentration (normality) of the ammonia. For 1 n. ammonia in water at 25° the molecular vapor pressure was 13.45 mm. Hg. For 0.5 n. solution it was 13.27 mm. Hg.

Since it has been shown by much experimental evidence, that Henry's law, the proportionality of the concentration in the liquid and vapor phase, holds very closely in the present case, see also Gaus (1900), it follows that the molecular vapor pressure relation of two solutions of equal ammonia content is normally proportional to the solubility relation of the ammonia in them. To calculate the solubility from the vapor pressures, it is only necessary to divide the value for the molecular vapor pressure in  $H_2O$  by that for the salt solution. Thus the solubility of  $NH_3$  in  $H_2O$  becomes unity. All determinations were made with 1 n. aqueous ammonia in salt solution of 0.5, 1 and 1.5 normal. The figures therefore show mols.  $NH_3$  per liter of the particular salt solution at 25°. In a later paper by Riesenfeld (1903), additional determinations are given for 35°.

Salt Solution.	Mols. $NH_3$ per Liter Salt Sol. of:			Salt Solution.	Mols. $NH_3$ per Liter Salt Sol. of:		
	0.5 n.	1 n.	1.5 n.		0.5 n.	1 n.	1.5 n.
KCl	0.930	0.866	0.809	KCN	0.926	0.858	0.791
KBr	0.950	0.904	0.857	KCNS	0.932	0.868	0.804
KI	0.970	0.942	0.900	$K_2SO_4$	0.875	0.772	0.669
KOH	0.852	0.716	0.607	$K_2SO_3$	0.865	0.768	0.671
NaCl	0.938	0.889	0.843	$K_2CO_3$	0.788	0.650	0.512
NaBr	0.965	0.916	0.890	$K_2C_2O_4$	0.866	0.771	0.676
NaI	0.995	0.992	0.985	$K_2CrO_4$	0.866	0.771	0.676
NaOH	0.876	0.789	0.716	$CH_3COOK$	0.866	0.765	0.664
LiCl	0.980	1.008	1.045	HCOOK	0.868	0.760	0.658
LiBr	1.001	1.040	1.090	$KBO_3$	0.814	0.677	0.540
LiI	1.030	1.094	1.190	$K_2HPO_4$	0.860	0.749	0.638
LiOH	0.863	0.808	0.768	$Na_2S$	0.887	0.795	0.703
KF	0.839	0.722	0.626	* $KClO_3$	0.927	...	...
$KNO_3$	0.923	0.862	0.804	* $KBrO_3$	0.940	...	...
$KNO_2$	0.920	0.855	0.798	* $KIO_3$	0.951	...	...

\* These salt solutions are 0.25 normal.

Konowalow (1898) expressed the results of determinations of the solubility of ammonia in aqueous silver nitrate by the equation  $H = 56.58 (m - 2)n$ , in which  $H$  = partial pressure of  $NH_3$  in mm. of Hg.,  $m$  = molecular concentration of  $NH_3$  and  $n$  = molecular concentration of  $AgNO_3$ . Similar results are given in later papers (Konowalow, 1899, a, b) for a large number of other solutions.

Gaus (1900) gives data for the vapor pressure of ammonia in aqueous solutions of about 20 salts, only a few of which occur in the above table.



## SOLUBILITY OF AMMONIA IN ABSOLUTE ETHYL ALCOHOL.

(Delepine — J. pharm. chim. [5] 25, 496, 1892; de Bruyn — Rec. trav. chim. 11, 112, '92.)

t°.	Density.	Gms. NH <sub>3</sub> per 100 cc. Solution.	Gms. NH <sub>3</sub> per 100 Gms. Solution.		Gms. NH <sub>3</sub> per 100 Gms. Alcohol	
			(Delepine.)	(de Bruyn.)	(Delepine.)	(de Bruyn.)
0	0.782	13.05	20.95	19.7	26.5	24.5
5	0.784	12.00	19.00	17.5	23.0	21.2
10	0.787	10.85	16.43	15.0	19.6	17.8
15	0.789	9.20	13.00	13.2	15.0	15.2
20	0.791	7.50	10.66	11.5	11.9	13.2
25	0.794	6.00	10.0	10.0	11.0	11.2
30	0.798	5.15	9.7	8.8	10.7	9.5

According to Müller (1891), one volume of alcohol absorbs 340 volumes of ammonia at 20° and 760 mm. pressure.

## SOLUBILITY OF AMMONIA IN AQUEOUS ETHYL ALCOHOL.

(Delepine.)

t°.	In 96% Alcohol.		In 90% Alcohol.		In 80% Alcohol.	
	Sp. Gr. Solution.	G. NH <sub>3</sub> per 100 Gms. Sol.	Sp. Gr. Solution.	G. NH <sub>3</sub> per 100 Gms. Sol.	Sp. Gr. Solution.	G. NH <sub>3</sub> per 100 Gms. Sol.
0	0.783	24.5	0.800	30.25	0.808	39.0
10	0.803	18.6	0.794	28.8	0.800	28.8
20	0.788	14.8	0.795	15.8	0.821	19.1
30	0.791	10.7	0.796	11.4	0.826	12.2

t°.	In 60% Alcohol.		In 50% Alcohol.	
	Sp. Gr. Solution.	G. NH <sub>3</sub> per 100 Gms. Sol.	Sp. Gr. Solution.	G. NH <sub>3</sub> per 100 Gms. Sol.
0	0.830	50.45	0.835	69.77
10	0.831	37.3	0.850	43.86
20	0.842	26.1	0.869	33.8
30	0.846	21.2	0.883	25.2

## SOLUBILITY OF AMMONIA IN ABSOLUTE METHYL ALCOHOL.

(de Bruyn — Rec. trav. chim. 11, 112, '92.)

t°.	G. NH <sub>3</sub> per 100 Grams.		t°.	G. NH <sub>3</sub> per 100 Grams.	
	Solution.	Alcohol.		Solution.	Alcohol.
0	29.3	41.5	20	19.2	23.8
5	26.5	36.4	25	16.5	20.0
10	24.2	31.8	30	14.0	16.0
15	21.6	27.8			

## SOLUBILITY OF AMMONIA IN ETHYL ETHER.

(Christoff, 1912.)

Results in terms of the Ostwald Solubility Expression (see page 227), at 0° = 17.13, at 10° = 12.35, at 15° = 10.27.

Freezing-point lowering curves (Solubility, see footnote, page 1) are given by Baume and Perrot (1910), (1914) for mixtures of ammonia and methyl alcohol and for mixtures of ammonia and methyl ether; results for ammonium and potassium, ammonium and sodium, and ammonium and lithium are given by Ruff and Geisel (1906); results for ammonium and hydrogen sulfide are given by Scheffer (1912).

## SOLUBILITY OF AMMONIA IN HYDROXYLAMINE.

(de Bruyn, 1892.)

100 gms. of the sat. solution contain 26 gms. NH<sub>3</sub> at ±0° and 19–20 gms. at 5°–16°.



## DISTRIBUTION OF AMMONIA BETWEEN:

Water and Amyl Alcohol at 20°.

(Herz and Fischer — Ber. 37, 4747, '04)

Water and Chloroform at :

(Dawson and McCrae — J. Ch. Soc. 79, 496, also Hantzsch and Sebaldt — Z. phys. Ch. 36, 2

Gms. NH <sub>3</sub> per 100 cc.		G. M. NH <sub>3</sub> per 100 cc.		Gms. NH <sub>3</sub> per 100 cc.		G. M. NH <sub>3</sub> per 100 cc.	
Aq. Layer.	Alcoholic Layer.	Aq. Layer.	Alcoholic Layer.	Aq. Layer.	CHCl <sub>3</sub> Layer.	Aq. Layer.	CHCl <sub>3</sub> Layer.
0.5	0.072	0.25	0.0035	0.2	0.007	0.01	0.00
1.0	0.147	0.50	0.0073	0.4	0.015	0.02	0.00
2.0	0.272	1.00	0.0148	0.6	0.023	0.03	0.00
3.0	0.438	2.00	0.0295	0.8	0.031	0.04	0.00
4.0	0.595	3.00	0.0460	1.0	0.039	0.05	0.00
5.0	0.756			1.2	0.046	0.06	0.00
				1.4	0.055	0.08	0.00
				1.6	0.063	0.10	0.00

For calculations of above distribution results see Note, page 6.

Additional data for the distribution of ammonia between water and chloroform are given by Dawson and McCrae (1900), (1901a), (1901b); Dawson (1909); Abbott and Bray (1907); Sherrill and Russ (1907); Bell (1911) by Moore and Winnill (1912). The results show that with increase of concentration of ammonia, the relative amount in the aqueous layer diminishes. Bell found that at 25° the distribution ratio is 22.7 when the aqueous layer contains 1.02 gm. mols. NH<sub>3</sub> per liter and only 10 when 12.23 gm. mols. NH<sub>3</sub> are present in the aqueous layer. The influence of increase of temperature was also found to be in the direction of diminution of the relative amount in the aqueous layer.

The influence of the presence of a large number of salts in the aqueous solution has been studied by several of the above-mentioned investigators. In the case of copper, zinc and cadmium salts (Dawson and McCrae, 1900), (Dawson, 1909), the distribution ratio varied with salt concentration in a manner indicating that metal ammonia compounds were formed.

Results for the effect of KOH, NaOH and Ba(OH)<sub>2</sub> on the distribution of ammonia are given by Dawson (1909).

Results for the effect of ammonium chromate upon the distribution of ammonia are given by Sherrill and Russ (1907).

Results for the distribution of ammonia between water and mixtures of chloroform and amyl alcohol at 25° are given by Herz and Kurzer (1910).

## DISTRIBUTION OF AMMONIA BETWEEN TOLUENE AND AIR.

(Hantzsch and Vagt, 1901.)

t°.	Gms. NH <sub>3</sub> per 1000 cc.		Mols. NH <sub>3</sub> per 1000 cc.	
	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> Layer.	Air.	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> Layer.	Air.
0	0.366	0.0396	0.0215	0.00233
10	0.357	0.0435	0.0210	0.00256
20	0.326	0.0451	0.0192	0.00265
30	0.286	0.0462	0.0168	0.00272



**AMMONIUM ACETATE**  $\text{CH}_3\text{COONH}_4$ .

100 cc. of sat. solution in acetone contain 0.27 gm.  $\text{CH}_3\text{COONH}_4$  at 19°.

(Roshdestwensky and Lewis, 1912.)

**AMMONIUM ARSENATES.****THE SYSTEM AMMONIA, ARSENIC TRIOXIDE AND WATER AT 30°.**

(Schreinemakers and de Baat, 1915.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{NH}_3$	$\text{As}_2\text{O}_3$		$\text{NH}_3$	$\text{As}_2\text{O}_3$	
0	2.26	$\text{As}_2\text{O}_3$	3.13	12.30	$\text{NH}_4\text{AsO}_2$
1.41	10.98	"	3.91	7.63	"
2.78	20.49	"	6.95	4.72	"
2.86	21.17	"	9.93	3.20	"
2.88	18.43	$\text{NH}_4\text{AsO}_2$	4.28	2.16	"

Data are also given for the system  $\text{NH}_4\text{Cl} + \text{As}_2\text{O}_3 + \text{H}_2\text{O}$  at 30°.

100 gms.  $\text{H}_2\text{O}$  dissolve 0.02 gm.  $\text{NH}_4\text{CaAsO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ .

(Field, 1873.)

" " " " 0.014 "  $\text{NH}_4\text{MgAsO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ .

**SOLUBILITY OF AMMONIUM MAGNESIUM ARSENATE IN WATER AND IN AQUEOUS SOLUTIONS OF AMMONIUM SALTS.**

(Wenger, 1911.)

Gms.  $\text{NH}_4\text{MgAsO}_4$  per 100 Gms. of Each Solvent.

F.	Aq. Solutions						Solid Phase.
	Water.	Aq. 5% NH <sub>4</sub> NO <sub>3</sub>	Aq. 5% NH <sub>4</sub> Cl	Aq.° NH <sub>4</sub> OH.	Aq. NH <sub>4</sub> OH † + 5% H <sub>2</sub> Cl.	Aq. NH <sub>4</sub> OH † + 10% NH <sub>4</sub> Cl.	
0	0.0339	0.092	0.084	0.0087	...	...	NH <sub>4</sub> MgAsO <sub>4</sub> ·6H <sub>2</sub> O
20	0.0207	0.114	0.113	0.0096	0.013	0.032	"
30	...	0.118	0.113	...	...	...	"
40	0.0275	0.139	0.190	0.0117	...	...	"
50	0.0226	0.189	0.189	0.0100	...	...	"
60	0.0210	0.211	0.219	0.0090	0.047	0.054	"
70	0.0156	0.189	0.221	0.0095	...	...	"
80	0.0236	0.189	0.231	0.0091	...	...	"

\* Composed of 1 part  $\text{NH}_3$  ( $d = 0.96$ ) + 4 parts  $\text{H}_2\text{O}$ .

† Contained 4 parts  $\text{NH}_3$  ( $d = 0.96$ ) per 100 parts  $\text{NH}_4\text{Cl}$  solution.

**AMMONIUM BENZOATE**  $\text{C}_6\text{H}_5\text{COONH}_4$ .**SOLUBILITY IN WATER AND IN AQUEOUS ALCOHOL AT 25°.**

(Seidell, 1910.)

Gms. $\text{C}_6\text{H}_5\text{OH}$ per 100 Gms. Solvent.	$d_{20}$ of Sat. Sol.	Gms. $\text{C}_6\text{H}_5\text{COONH}_4$ per 100 Gms. Sat. Sol.	Gms. $\text{C}_2\text{H}_5\text{OH}$ per 100 Gms. Solvent.	$d_{20}$ of Sat. Sol.	Gms. $\text{C}_6\text{H}_5\text{COONH}_4$ per 100 Gms. Sat. Sol.
0	1.043	18.6	60	0.930	15
10	1.027	18	70	0.901	12.2
20	1.012	18	80	0.864	8.3
30	0.997	18.1	90	0.828	4.2
40	0.979	18	95	0.810	2.7
50	0.956	17	100	0.796	1.6

100 gms. water dissolve 19.6 gms.  $\text{C}_6\text{H}_5\text{COONH}_4$  at 14° 5,  $d_{14}$  of sat. sol. = 1.042.

(Greenish and Smith, 1901.)

100 gms. water dissolve 83.33 gms.  $\text{C}_6\text{H}_5\text{COONH}_4$  at b.-pt.

(U. S. P.)

100 gms. glycerol dissolve 10 gms.  $\text{C}_6\text{H}_5\text{COONH}_4$  at room temp.

(Hager.)



# AMMONIUM BORATES

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## THE SYSTEM AMMONIA, BORIC ACID AND WATER AT 30° AND AT 60°.

(Sborgi, 1913-15; Sborgi and Meccacci, 1916.)

Results at 30°.			Results at 60°.		
Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase
(NH <sub>4</sub> ) <sub>2</sub> O.	B <sub>2</sub> O <sub>3</sub> .		(NH <sub>4</sub> ) <sub>2</sub> O.	B <sub>2</sub> O <sub>3</sub> .	
0.23	4.81	H <sub>3</sub> BO <sub>3</sub>	0	7.39	H <sub>3</sub> BO <sub>3</sub>
0.70	7.20	"	0.78	12.12	"
0.78	7.62	H <sub>3</sub> BO <sub>3</sub> +1.5.8	1.42	15.60	H <sub>3</sub> BO <sub>3</sub> +1.5
0.99	7.53	1.5.8	1.70	15.29	1.5.8
1.08	7.66	"	3.23	18.60	"
1.71	9.13	"	4.02	20.38	1.5.8+1.4.1
2.25	10.71	"	4.88	21.76	1.4.6
2.89	12.32	"	6.41	24.32	"
3.13	12.59	"	7.90	27.31	1.4.6+1.2.4
3.43	6.35	2.4.5	7.83	26.76	1.2.4
6.51	4.48	"	7.91	17.57	"
10.45	3.37	"	9.57	13.56	"
18.05	2.02	"	15.45	8.33	"
24.80	1.51	"	19.47	5.92	"
30.56	1.22	"	22.57	4.47	"
45.34	0.84	"			

1.5.8 = (NH<sub>4</sub>)<sub>2</sub>O.5B<sub>2</sub>O<sub>3</sub>.8H<sub>2</sub>O

1.4.6 = (NH<sub>4</sub>)<sub>2</sub>O.4B<sub>2</sub>O<sub>3</sub>.6H<sub>2</sub>O

2.4.5 = 2(NH<sub>4</sub>)<sub>2</sub>O.4B<sub>2</sub>O<sub>3</sub>.5HO<sub>2</sub>

1.2.4 = (NH<sub>4</sub>)<sub>2</sub>O.2B<sub>2</sub>O<sub>3</sub>.4H<sub>2</sub>O

# AMMONIUM BROMIDE NH<sub>4</sub>Br.

## SOLUBILITY IN WATER.

(Smith and Eastlack, 1916.)

(Determinations by sealed tube method.)

t°.	Gms. NH <sub>4</sub> Br per 100 Gms. H <sub>2</sub> O.	t°.	Gms. NH <sub>4</sub> Br per 100 Gms. H <sub>2</sub> O.	t°.	Gms. NH <sub>4</sub> Br per 100 Gms. H <sub>2</sub> O.
-17 Eutec.	47.3	60	107.8	130	180
0	60.6	70	116.8	137.3	Transition p
10	68	80	126	140	192.3
20	75.5	90	135.6	150	202.5
30	83.2	100	145.6	160	213.4
40	91.1	110	156.5	170	225.5
50	99.2	120	167.8		

## SOLUBILITY OF AMMONIUM BROMIDE IN ABSOLUTE ETHYL ALCOHOL, METHYL ALCOHOL, AND IN ETHER.

(Eder; de Bruyn — Z. phys. Ch. 10, 783, '92.)

t°.	In Ethyl Alcohol. Gms. NH <sub>4</sub> Br per 100 Grams.		In Methyl Alcohol. Gms. NH <sub>4</sub> Br per 100 Grams.		In Ether (0.729 Sp. G.) Gms. NH <sub>4</sub> Br per 100 Grams.
	Solution.	Alcohol.	Solution	Alcohol.	Ether.
15	2.97	3.06	....	....	0.123
19	3.12	3.22	11.1	12.5	....
78	9.50	10.50	....	....	....

100 cc. ethyl alcohol of  $d_{15} = 0.8352$  dissolve 7.8 grams NH<sub>4</sub>Br at 15°,  $d_{15}$  sat. sol. = 0.8848. (Greenish, 19

100 cc. anhydrous hydrazine dissolve 110 gms. NH<sub>4</sub>Br at room temp. w evolution of ammonia. (Welsh and Broderson, 19



**AMMONIUM BROMIDE**

SOLUBILITY OF AMMONIUM BROMIDE AT 25° IN MIXTURES OF:  
(Herz and Kuhn, 1908.)

Methyl and Ethyl Alcohols.			Propyl and Methyl Alcohols.			Propyl and Ethyl Alcohols.		
Gms. CH <sub>3</sub> OH per 100 Gms. Solvent.	d <sub>4</sub> <sup>20</sup> of Sat. Sol.	Gms. NH <sub>4</sub> Br per 100 cc. Sat. Sol.	Gms. C <sub>3</sub> H <sub>7</sub> OH per 100 Gms. Solvent.	d <sub>4</sub> <sup>20</sup> of Sat. Sol.	Gms. NH <sub>4</sub> Br per 100 cc. Sat. Sol.	Gms. C <sub>3</sub> H <sub>7</sub> OH per 100 Gms. Solvent.	d <sub>4</sub> <sup>20</sup> of Sat. Sol.	Gms. NH <sub>4</sub> Br per 100 cc. Sat. Sol.
0	0.8065	2.55	0	0.8605	9.83	0	0.8065	2.55
4.37	0.8083	2.99	11.11	0.8524	8.51	8.51	0.8062	2.51
10.40	0.8117	3.21	23.8	0.8426	6.90	17.85	0.8052	2.37
41.02	0.8252	5.06	65.2	0.8184	3.08	56.6	0.8048	1.63
80.69	0.8501	8.13	91.8	0.8097	1.28	88.6	0.8042	1.11
84.77	0.8508	8.47	93.75	0.8089	1.25	91.2	0.8049	1.05
91.25	0.8551	9.34	100	0.8059	0.95	95.2	0.8059	1.04
100	0.8605	9.83				100	0.8059	0.95

**AMMONIUM Cadmium BROMIDE** (NH<sub>4</sub>)CdBr<sub>3</sub>·½H<sub>2</sub>O.

100 parts water dissolve 137 parts of the salt; 100 parts of alcohol dissolve 16.8 parts and 100 parts of ether dissolve 0.36 part. (Eder, 1876.)

**AMMONIUM Platinum BROMIDE** (NH<sub>4</sub>)<sub>2</sub>PtBr<sub>6</sub>.

100 gms. sat. aqueous solution contain 0.59 gm. salt at 20°. (Halberstadt, 1884.)

SOLUBILITY OF TETRA ETHYL **AMMONIUM BROMIDE** N(C<sub>2</sub>H<sub>5</sub>)<sub>4</sub>Br, AND OF  
TETRA METHYL AMMONIUM BROMIDE N(CH<sub>3</sub>)<sub>4</sub>Br IN ACETONITRILE.

(Walden — Z. phys. Ch., 55, 712, '06.)

100 cc. sat. solution in CH<sub>3</sub>CN contain 9.59 gms. N(C<sub>2</sub>H<sub>5</sub>)<sub>4</sub>Br at 25°.

100 cc. sat. solution in CH<sub>3</sub>CN contain 0.17 gm. N(CH<sub>3</sub>)<sub>4</sub>Br at 25°.

SOLUBILITY OF TETRA ETHYL AMMONIUM BROMIDE IN WATER AND  
IN CHLOROFORM AT 25°.

(Peddle and Turner, 1913.)

100 gms. H<sub>2</sub>O dissolve 279.5 gms. N(C<sub>2</sub>H<sub>5</sub>)<sub>4</sub>Br.

100 gms. CHCl<sub>3</sub> dissolve 25.01 gms. N(C<sub>2</sub>H<sub>5</sub>)<sub>4</sub>Br.

Data for the distribution of propyl benzyl methyl phenyl **AMMONIUM BROMIDE** between water and chloroform at 25° are given by Wedekind and Paschke (1910).

**AMMONIUM CARBONATE** (NH<sub>4</sub>)<sub>2</sub>CO<sub>3</sub>.

100 gms. H<sub>2</sub>O dissolve 25.4 gms. ammonium carbonate, calculated as C<sub>18</sub>H<sub>16</sub>N<sub>2</sub>O<sub>6</sub> at 16.7° d of sat. sol. = 1.095. (Greenish and Smith, 1901.)

100 gms. of carefully purified glycerol dissolve 20 gms. (NH<sub>4</sub>)<sub>2</sub>CO<sub>3</sub> at 15°. (Ossendowski, 1907.)

**AMMONIUM BICARBONATE** NH<sub>4</sub>HCO<sub>3</sub>.

## SOLUBILITY IN WATER.

(Dibbits — J. pr. Ch. [2] 10, 417, '74.)

°.	Gms. NH <sub>4</sub> HCO <sub>3</sub> per 100 Grams.		°.	Grams NH <sub>4</sub> HCO <sub>3</sub> per 100 Grams.	
	Solution.	Water.		Solution.	Water.
0	10.6	11.9	20	17.4	21.0
5	12.1	13.7	25	19.3	23.9
10	13.7	15.8	30	21.3	27.0
15	15.5	18.3			



# AMMONIUM BICARBONATE

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## SOLUBILITY OF AMMONIUM BICARBONATE IN AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE SATURATED WITH CO<sub>2</sub>.

(Fedotieff — Z. phys. Ch. 49, 168, '04.)

t°.	Wt. of 1 cc. Sol.	Per 1000 cc. Solution.				Per 1000 Grams H <sub>2</sub> O.		
		G. M. NH <sub>4</sub> Cl.	G. M. NH <sub>4</sub> HCO <sub>3</sub> .	Gms. NH <sub>4</sub> Cl.	Gms. NH <sub>4</sub> HCO <sub>3</sub> .	G. M. NH <sub>4</sub> Cl.	G. M. NH <sub>4</sub> HCO <sub>3</sub> .	Gms. NH <sub>4</sub> Cl. N
0	...	...	...	...	...	0.0	1.22	0.0
0	1.077	4.41	0.37	235.9	29.2	5.42	0.46	290.8
15	1.064	0.0	2.12	0.0	167.2	0.0	2.36	0.0
15	1.063	0.5	1.84	26.8	145.2	0.56	2.06	29.9
15	1.062	1.0	1.59	53.5	125.5	1.13	1.80	60.6
15	1.062	1.41	1.42	75.4	112.2	1.59	1.60	85.1
15	1.065	1.89	4.28	100.8	101.1	2.18	1.48	116.8
15	1.069	2.87	0.99	153.3	78.2	3.42	1.18	183.0
15	1.076	3.84	0.79	205.2	62.5	5.03	0.98	269.3
15	1.085	4.82	0.65	257.9	51.4	6.21	0.84	332.5
15	1.085	4.95	0.62	264.8	48.9	6.40	0.81	343.5
30	...	...	...	...	...	0.0	3.42	0.0
30	...	...	...	...	...	7.4	1.15	397.0

## SOLUBILITY OF AMMONIUM BICARBONATE IN AQUEOUS SOLUTIONS OF SODIUM BICARBONATE SATURATED WITH CO<sub>2</sub>.

(Fedotieff.)

t°.	Wt. of 1 cc. Sol.	Per 1000 cc. Solution.				Per 1000 Grams H <sub>2</sub> O.		
		G. M. NaHCO <sub>3</sub> .	G. M. NH <sub>4</sub> HCO <sub>3</sub> .	Gms. NaHCO <sub>3</sub> .	Gms. NH <sub>4</sub> HCO <sub>3</sub> .	G. M. NaHCO <sub>3</sub> .	G. M. NH <sub>4</sub> HCO <sub>3</sub> .	Gms. NaHCO <sub>3</sub> . N
0	...	...	...	...	...	0.0	1.51	0.0
0	1.072	0.53	1.28	44.6	101.4	0.58	1.39	48.2
15	1.064	0.0	2.12	0.0	167.2	0.0	2.36	0.0
15	1.090	0.63	1.92	52.5	151.3	0.71	2.16	59.2
30	...	...	...	...	...	0.0	3.42	0.0
30	...	...	...	...	...	0.83	2.91	70.0

## SOLUBILITY OF AMMONIUM BICARBONATE IN AQUEOUS SOLUTIONS OF AMMONIUM NITRATE.

(Fedotieff and Koltunoff, 1914.)

t°.	d of Sat. Sol.	Gms. per 100 Gms. H <sub>2</sub> O.		t°.	d of Sat. Sol.	Gms. per 100 Gms.	
		NH <sub>4</sub> NO <sub>3</sub> .	NH <sub>4</sub> HCO <sub>3</sub> .			NH <sub>4</sub> NO <sub>3</sub> .	NH <sub>4</sub> HCO <sub>3</sub> .
0		0	11.90	15	1.242	103.4	
0	1.265	118	4.52	15	1.269	128.9	
15	1.064	0	18.64	15	1.302	166.9	
15	1.113	23.26	12.91	30	...	0	20
15	1.164	49.82	10.33	30	...	231.9	1



### 43 AMMONIUM BICARBONATE

#### SOLUBILITY OF MIXTURES OF AMMONIUM BICARBONATE, SODIUM BICARBONATE, AND AMMONIUM CHLORIDE IN WATER SATURATED WITH CO<sub>2</sub>.

(Fedotieff.)

t°.	Wt. of 1 cc. Sol.	Gram Mols. per 1000 Gms. H <sub>2</sub> O.			Gms. per 1000 Gms. H <sub>2</sub> O.			Solid Phase.
		NaHCO <sub>3</sub>	NaCl.	NH <sub>4</sub> Cl.	NaHCO <sub>3</sub>	NaCl.	NH <sub>4</sub> Cl.	
0	1.114	0.59	0.96	4.92	49.61	56.16	263.4	a + b + c
0	1.187	0.12	4.83	2.74	10.09	282.6	146.7	"
15	1.116	0.93	0.51	6.28	78.18	29.84	336.2	"
15	1.178	0.18	4.44	3.73	15.13	259.8	199.6	"
15	1.151	0.30	3.09	4.56	25.22	180.8	244.1	a + c
15	1.128	0.51	1.68	5.45	42.87	98.28	291.7	"
15	1.112	0.99	0.35	5.65	83.22	20.47	302.4	a + b
15	1.108	1.07	0.20	5.21	89.95	11.70	278.9	"
15	1.106	1.12	0.11	4.92	94.14	6.44	263.4	"
15	1.101	1.16	0.14	4.00	97.52	8.19	214.1	"
15	1.090	0.93	0.95	2.03	78.18	55.58	108.6	"

a = NaHCO<sub>3</sub>,

b = NH<sub>4</sub>HCO<sub>3</sub>,

c = NH<sub>4</sub>Cl.

#### AMMONIUM Uranyl CARBONATE 2(NH<sub>4</sub>)<sub>2</sub>CO<sub>3</sub>UO<sub>2</sub>CO<sub>3</sub>.

(Ebelmen.)

100 grams H<sub>2</sub>O dissolve 5 grams of the salt at 15°.

#### AMMONIUM Lead COBALTICYANIDE NH<sub>4</sub>PbCo(CN)<sub>6</sub>·3H<sub>2</sub>O.

(Schuler — Sitz. Ber. K. Akad. W. (Berlin) 79, 302.)

100 grams H<sub>2</sub>O dissolve 12 grams of the salt at 18°.

#### AMMONIUM PerCHLORATE NH<sub>4</sub>ClO<sub>4</sub>.

##### SOLUBILITY IN WATER.

(Carlton, 1910.)

t°.	Sp. Gr. Sat. Sol.	Gms. NH <sub>4</sub> ClO <sub>4</sub> per 100 cc. Sat. Sol.	t°.	Sp. Gr. Sat. Sol.	Gms. NH <sub>4</sub> ClO <sub>4</sub> per 100 cc. Sat. Sol.
0	1.059	11.56	80	1.193	48.19
20	1.098	20.85	100	1.216	57.01
40	1.128	30.58	107 b. pt.	1.221	59.12
60	1.158	39.05			

In a paper by Thin and Cumming (1915), it is stated that ammonium perchlorate is "sparingly soluble" in water and according to one determination at 14.2°, 100 gms. of the sat. solution was found to contain 1.735 gms. NH<sub>4</sub>ClO<sub>4</sub>. It is probable that these authors have misplaced the decimal point. This appears more probable since a determination of the solubility in 98.8 per cent ethyl alcohol at 25.2° gave 1.96 gms. NH<sub>4</sub>ClO<sub>4</sub> per 100 gms. sat. solution, and in 98.8 per cent alcohol containing 0.2 per cent HClO<sub>4</sub> gave 1.97 gms. per 100 gms. sat. solution.



# AMMONIUM PerCHLORATE 44

SOLUBILITY OF AMMONIUM PERCHLORATE AND SEVERAL OF ITS DERIVATIVES  
WATER AT 15°. (Hofmann, Hübald and Quoo (1911-12).)

	Gms. Salt per 100 Gms. H <sub>2</sub> O.		Gms. Salt per 100 Gms.
NH <sub>4</sub> ClO <sub>4</sub>	18.5	CH <sub>3</sub> (C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> NCIO <sub>4</sub>	2.3
CH <sub>3</sub> NH <sub>2</sub> ClO <sub>4</sub>	109.6	C <sub>3</sub> H <sub>7</sub> (C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> NCIO <sub>4</sub>	7
(CH <sub>3</sub> ) <sub>2</sub> NH <sub>2</sub> ClO <sub>4</sub>	208.7	(CH <sub>3</sub> ) <sub>3</sub> (C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> NCIO <sub>4</sub>	13.4
C <sub>2</sub> H <sub>5</sub> NH <sub>2</sub> ClO <sub>4</sub>	208.7	C <sub>2</sub> H <sub>3</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	5
(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> NH <sub>2</sub> ClO <sub>4</sub>	150.9	BrC <sub>2</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	3
(CH <sub>3</sub> ) <sub>2</sub> NHClO <sub>4</sub>	19.9	BrC <sub>2</sub> H <sub>3</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	2
(CH <sub>3</sub> ) <sub>4</sub> NCIO <sub>4</sub>	0.5	(OH)C <sub>2</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	290
(C <sub>2</sub> H <sub>5</sub> ) <sub>4</sub> NCIO <sub>4</sub>	3.7	(OH)CH <sub>2</sub> CH(OH)CH <sub>2</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	155
C <sub>6</sub> H <sub>5</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	17.9	NO <sub>2</sub> C <sub>2</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	0
ICH <sub>2</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	3.1	C <sub>3</sub> H <sub>5</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	199
C <sub>2</sub> H <sub>5</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	10.9	C <sub>2</sub> H <sub>4</sub> (NH <sub>2</sub> ClO <sub>4</sub> ) <sub>2</sub>	144
C <sub>3</sub> H <sub>7</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	15.4	C <sub>2</sub> H <sub>4</sub> [(CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub> ] <sub>2</sub>	1
C <sub>4</sub> H <sub>9</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	3.7	C <sub>3</sub> H <sub>6</sub> [(CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub> ] <sub>2</sub>	1
C <sub>5</sub> H <sub>11</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	2.2	Br <sub>2</sub> C <sub>2</sub> H <sub>3</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	2
		BrC <sub>3</sub> H <sub>3</sub> (CH <sub>3</sub> ) <sub>3</sub> NCIO <sub>4</sub>	2

Milbauer (1912-13) found that 100 gms. of cold H<sub>2</sub>O dissolve 1.126 gm. of methyl ammonium perchlorate (CH<sub>3</sub>)<sub>4</sub>NCIO<sub>4</sub> and 100 gms. alcohol dissolve 0.04 gm. of the salt.

## AMMONIUM CHLORIDE NH<sub>4</sub>Cl.

### SOLUBILITY IN WATER.

(Mulder; below 0°, Meerburg — Z. anorg. Ch. 37, 203, 1903.)

t°.	Gms. NH <sub>4</sub> Cl per 100 Gms.		t°.	Gms. NH <sub>4</sub> Cl per 100 Gms.	
	Solution.	Water.		Solution.	Water.
-15	19.7	24.5	40	31.4	45.8
-10 9	20.3	25.5	50	33.5	50.4
-5.7	21.7	27.7	60	35.6	55.2
0	22.7	29.4	70	37.6	60.2
+ 5	23.8	31.2	80	39.6	65.6
10	24.9	33.3	90	41.6	71.3
15	26.0	35.2	100	43.6	77.3
20	27.1	37.2	110	45.6	83.8
25	28.2	39.3	115.6	46.6	87.3
30	29.3	41.4			

Density of saturated solution at 0° = 1.088, at 15° = 1.077, at 19° = 1.075.  
Eutectic, Ice + NH<sub>4</sub>Cl = - 16° and 19.5 gms. NH<sub>4</sub>Cl per 100 gms. sat. sol.  
100 gms. H<sub>2</sub>O dissolve 31.25 gms. NH<sub>4</sub>Cl at 3.5°, 38.5 gms. at 25° and 49.6 gms. at 50°.

Data for the solubility of ammonium chloride in water at 0° under pressures up to 500 atmospheres are given by Stackelberg, 1896.

### SOLUBILITY OF AMMONIUM CHLORIDE IN AQUEOUS AMMONIUM BICARBONATE SOLUTIONS SATURATED WITH CO<sub>2</sub>. (Fedotieff — Z. Phys. Ch. 49, 169, 1904.)

t°.	Wt. of 1 cc. Sol.	Per 1000 cc. Solution.				Per 1000 Gms. Solution.			
		G. M. NH <sub>4</sub> HCO <sub>3</sub>	G. M. NH <sub>4</sub> Cl	Gms. NH <sub>4</sub> HCO <sub>3</sub>	Gms. NH <sub>4</sub> Cl	G. M. NH <sub>4</sub> HCO <sub>3</sub>	G. M. NH <sub>4</sub> Cl	Gms. NH <sub>4</sub> HCl	Gms. NH <sub>4</sub> Cl
0	1.069	0.0	4.60	0.0	246.1	0.0	5.57	0.0	298.0
0	1.077	0.37	4.41	29.2	235.9	0.46	5.42	36.0	290.8
15	1.077	0.0	5.29	0.0	283.1	0.0	6.64	0.0	355.0
15	1.085	0.62	4.95	48.9	264.8	0.81	6.40	64.2	343.5
30	...	...	...	...	...	0.0	7.78	0.0	416.4
30	...	...	...	...	...	1.15	7.40	91.0	397.0



## SOLUBILITY IN AQUEOUS AMMONIA SOLUTIONS AT 0°.

(Engel — Bull. soc. chim. [3] 6, 17, 1891.)

Sp. Gr. of Solutions.	Milligram Molecules per 10 cc. Solution.		Grams per 100 cc. Solution.	
	NH <sub>3</sub>	NH <sub>4</sub> Cl.	NH <sub>4</sub> OH.	NH <sub>4</sub> Cl.
1.067	5.37	45.8	0.92	24.52
1.054	12.02	45.5	2.05	24.35
1.031	38.0	44.5	6.48	23.82
1.025	47.0	44.0	8.02	23.56
1.017	54.5	43.63	9.30	23.35
0.993	80.0	43.12	13.66	23.09
0.992	90.0	44.0	15.36	23.56
0.983	95.5	44.37	16.29	23.75
0.953	130.0	49.75	22.18	26.63
0.931	169.75	60.0	28.97	32.14

SOLUBILITY OF NH<sub>4</sub>Cl IN AQUEOUS AMMONIA SOLUTIONS AT 17.5°.

(Strömholm, 1908.)

Normality Equiv. per Liter.		Gms. per 1000 cc. Solution.	
NH <sub>3</sub>	NH <sub>4</sub> Cl.	NH <sub>3</sub>	NH <sub>4</sub> Cl.
0	5.435	0	290.8
0.15	5.420	2.55	290
4.76	5.082	81	271.9

SOLUBILITIES OF MIXTURES OF AMMONIUM CHLORIDE AND OTHER SALTS  
IN WATER.

(Rüchhoff, Karsten, Mulder.)

Both salts present in solid phase.

°.	Grams per 100 Grams H <sub>2</sub> O.		°.	Grams per 100 Grams H <sub>2</sub> O.	
19.5	29.2 NH <sub>4</sub> Cl + 174.0 NH <sub>4</sub> NO <sub>3</sub>	R	b. pt.	67.7 NH <sub>4</sub> Cl + 21.9 KCl	M
21.5	26.8 " + 46.5 (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	R	14.8	38.8 " + 34.2 KNO <sub>3</sub>	K
20.0	33.8 " + 11.6 BaCl <sub>2</sub>	R	18.5	39.8 " + 38.6 KNO <sub>3</sub>	K
18.5	39.2 " + 17.0 Ba(NO <sub>3</sub> ) <sub>2</sub>	K	14.0	36.8 " + 14.1 K <sub>2</sub> SO <sub>4</sub>	R
15.0	28.9 " + 16.9 KCl	R	18.7	37.9 " + 13.3 K <sub>2</sub> SO <sub>4</sub>	K
22.0	30.4 " + 19.1 KCl	R	18.7	22.9 " + 23.9 NaCl	R

SOLUBILITY OF AMMONIUM CHLORIDE IN AQUEOUS SOLUTIONS OF AMMONIUM  
SULFATE AT 30°.

(Wibaut, 1909; Schreinemakers, 1910.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	NH <sub>4</sub> Cl.		(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	NH <sub>4</sub> Cl.	
0	29.5	NH <sub>4</sub> Cl	25	18.3	NH <sub>4</sub> Cl + (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>
5	28.5	"	30	13.2	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>
10	25.7	"	35	8.5	"
15	23.2	"	40	2.8	"
20	20.2	"	42	0	"

SOLUBILITY OF MIXTURES OF AMMONIUM CHLORIDE AND COBALT CHLORIDE  
IN WATER AT 25°.

(Footé, 1912.)

Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Solid Residue.			Solid Phase.
NH <sub>4</sub> Cl.	CoCl <sub>2</sub> .	NH <sub>4</sub> Cl.	CoCl <sub>2</sub> .	H <sub>2</sub> O.	
17.90	15.63	...	3.2	...	Mixed crystals of NH <sub>4</sub> Cl + CoCl <sub>2</sub> . 2H <sub>2</sub> O
13.59	25.19	83.01	13.52	3.47	
8.75	34.28	35.12	50.66	14.22	
7.45	35.24	34.02	49.64	16.31	Mixed crystals + CoCl <sub>2</sub> .6H <sub>2</sub> O
7.62	34.61	7.07	55.27	37.66	



# AMMONIUM CHLORIDE

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## SOLUBILITY OF AMMONIUM CHLORIDE IN AQUEOUS HYDROCHLORIC ACID

Results at 0°. (Engel, 1888.)			Results at 25°. (Armstrong and Eyre, 1888.)		
Sp. Gr. of Sat. Sol.	Gms. per 100 cc. sat. sol.		Gms. HCl per 100 Gms. H <sub>2</sub> O.	Gms. N. per 100 Gms. Sol.	
	HCl.	NH <sub>4</sub> Cl.			
1.076	0	24.61	0	1.080	28
1.069	1.05	23.16	0.91	1.079	27
1.070	1.99	21.78	1.82	1.082	26
1.073	3.93	19.36	3.65	1.083	24
1.078	7.74	14.54	18.25	1.099	11
1.106	19.18	5.78			
1.114	22.07	4.67			

## SOLUBILITY OF MIXTURE OF AMMONIUM CHLORIDE AND LEAD CHLORIDE IN WATER AT SEVERAL TEMPERATURES.

(At 17°, 50° and 100° Demassieux (1913) at 25° Foote and Levy, 1907.)

At 17°.		At 25°.		At 50°.		At 100°.		Sol. in
Gms. per 100 Gms. Sol.	Gms. Sol.	Gms. per 100 Gms. Sol.	Gms. Sol.	Gms. per 100 Gms. Sol.	Gms. Sol.	Gms. per 100 Gms. Sol.	Gms. Sol.	
PbCl <sub>2</sub> .	NH <sub>4</sub> Cl.	PbCl <sub>2</sub> .	NH <sub>4</sub> Cl.	PbCl <sub>2</sub> .	NH <sub>4</sub> Cl.	PbCl <sub>2</sub> .	NH <sub>4</sub> Cl.	
0.30	27.03	...	...	0.32	34.14	1.61	43.42	NH
0.52	26.68	...	...	2.65	33.62	4.21	42.91	"
0.64	26.49	1.20	28.15	3.96	33.56	...	...	"
...	...	...	...	...	...	9.26	41.90	"
...	...	...	...	...	...	9.88	40.22	2.1
...	...	...	...	...	...	11.60	38.32	"
...	...	...	...	...	...	12.67	37.62	"
0.34	22.32	0.93	27.45	3.31	31.90	11.40	36.29	1.2
0.098	12.36	0.35	21.59	1.76	27.16	8.32	32.64	"
0.078	4.93	0.29	17.97	0.71	19.42	4.54	26.08	"
0.078	4.23	0.11	10.25	0.49	12.45	1.98	13.12	"
0.076	3.48	0.03	2.77	0.48	4.86	1.76	8.59	"
0.16	1.43	...	...	0.67	1.45	1.85	5.33	1
0.21	0.96	...	...	1.08	0.51	2.02	1.32	
0.89	0	...	...	1.69	0	3.10	0	

1.2 = NH<sub>4</sub>Cl.2(PbCl<sub>2</sub>), 2.1 = 2NH<sub>4</sub>Cl.PbCl<sub>2</sub>.

The following additional data for the above system at 22° are given by Foote (1909).

Gm. Equiv. NH <sub>4</sub> Cl per 100 Gms. H <sub>2</sub> O.	Gm. Equiv. PbCl <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	Gm. Equiv. NH <sub>4</sub> Cl per 100 Gms. H <sub>2</sub> O.	Gm. Equiv. PbCl <sub>2</sub> per 100 Gms. Sat. Sol.	Solid
0	7.49 × 10 <sup>-3</sup>	PbCl <sub>2</sub>	0.8	0.837 × 10 <sup>-3</sup>	2PbC
0.1	3.10 × 10 <sup>-3</sup>	"	1	0.758 × 10 <sup>-3</sup>	"
0.2	1.916 × 10 <sup>-3</sup>	"	2	0.695 × 10 <sup>-3</sup>	"
0.4	1.348 × 10 <sup>-3</sup>	"	3	0.968 × 10 <sup>-3</sup>	"
0.5	1.263 × 10 <sup>-3</sup>	"	4	1.502 × 10 <sup>-3</sup>	"
0.55	1.189 × 10 <sup>-3</sup>	2PbCl <sub>2</sub> .NH <sub>4</sub> Cl	5	2.338 × 10 <sup>-3</sup>	"
[0.6	1.092 × 10 <sup>-3</sup>	"	6	3.580 × 10 <sup>-3</sup>	"
0.7	0.956 × 10 <sup>-3</sup>	"	7.29 sat.	6.46 × 10 <sup>-3</sup>	"

The two curves intersect at 0.52 normal NH<sub>4</sub>Cl.

## SOLUBILITY OF MIXTURES OF AMMONIUM CHLORIDE AND MAGNESIUM CHLORIDE IN WATER. (Riltz and Marcus, 1911.)

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.		Solid F
	MgCl <sub>2</sub> .	NH <sub>4</sub> Cl.			MgCl <sub>2</sub> .	NH <sub>4</sub> Cl.	
3.5	21.41	5.93	NH <sub>4</sub> Cl + MgCl <sub>2</sub> .6H <sub>2</sub> O	3.5	34.43	0.09	(NH <sub>4</sub> )MgCl <sub>2</sub>
25	20.95	8.78	"	25	35.41	0.09	" + Mg
50	20.84	12.46	"	50	36.92	0.15	"



**SOLUBILITY OF MIXTURES OF AMMONIUM AND MANGANESE CHLORIDES IN WATER AT 25°.**

(Foote and Saxton, 1914.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
NH <sub>4</sub> Cl	MnCl <sub>2</sub>		NH <sub>4</sub> Cl	MnCl <sub>2</sub>	
23.97	7.97	α mixed crystals	17.09	18.76	β mixed crystals or double salt 2NH <sub>4</sub> Cl·MnCl <sub>2</sub> ·2H <sub>2</sub> O
22.94	9.65		15.05	22.44	
21.44	12.31		13.17	24.52	
21.18	13.38		9.15	29.24	
20.10	15.19		5.90	34.78	
19.70	15.92	α and β mixed crystals	3.77	39.48	2NH <sub>4</sub> Cl·MnCl <sub>2</sub> ·2H <sub>2</sub> O + MnCl <sub>2</sub> ·2H <sub>2</sub> O
19.75	16.02		2.98	43.71	
19.67	15.47		2.94	43.44	

α mixed crystals consist of NH<sub>4</sub>Cl with varying amounts of MnCl<sub>2</sub>·2H<sub>2</sub>O;  
β mixed crystals consist of the double salt 2NH<sub>4</sub>Cl·MnCl<sub>2</sub>·2H<sub>2</sub>O with excess of NH<sub>4</sub>Cl.

This case represents a very rare type of solid solution "in which a single salt and a double salt are each capable of taking up very considerable quantities of the other to form homogeneous mixed crystals."

**EQUILIBRIUM IN THE SYSTEM AMMONIUM CHLORIDE, MERCURIC CHLORIDE, WATER AT 30°.**

(Meerburg, 1908.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
HgCl <sub>2</sub>	NH <sub>4</sub> Cl		HgCl <sub>2</sub>	NH <sub>4</sub> Cl	
0	29.50	NH <sub>4</sub> Cl	57.05	9.92	3.2.1
22.80	26.91	"	58.65	9.20	" + 9.2
42.45	25.05	"	*51.83	8.76	9.2
50.05	24.79	" 1.2.1	*46	7.52	"
53.08	22.77	1.2.1	*35.60	5.26	"
58.90	20.02	" + 1.1.1	*32.90	5.06	"
56.38	18.50	1.1.1	29.65	3.62	" + HgCl <sub>2</sub>
55.58	16.82	"	40.12	5.13	HgCl <sub>2</sub>
57.01	14.12	" + 3.2.1	21	2.29	"
56.26	13.04	3.2.1	7.67	0	"

1.2.1 = HgCl<sub>2</sub>·2NH<sub>4</sub>Cl·H<sub>2</sub>O; 1.1.1 = HgCl<sub>2</sub>·NH<sub>4</sub>Cl·H<sub>2</sub>O;

3.2.1 = 3HgCl<sub>2</sub>·2NH<sub>4</sub>Cl·H<sub>2</sub>O; 9.2 = 9HgCl<sub>2</sub>·2NH<sub>4</sub>Cl.

\* In these solutions 2 to 3 weeks were required for attainment of equilibrium.

**SOLUBILITY OF MIXTURES OF AMMONIUM AND NICKEL CHLORIDES IN WATER AT 25°.**

(Foote, 1912.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
NH <sub>4</sub> Cl	NiCl <sub>2</sub>		NH <sub>4</sub> Cl	NiCl <sub>2</sub>	
26.07	3.10	Mixed crystals of NH <sub>4</sub> Cl and NiCl <sub>2</sub> ·6H <sub>2</sub> O	7.98	37.41	Mixed crystals and NiCl <sub>2</sub> ·6H <sub>2</sub> O
22.27	8.04		8.07	37.73	
20.68	10.32		8.23	37.45	
17.43	15.01		8.17	37.64	
11.22	26.93		7.51	37.19	NiCl <sub>2</sub> ·6H <sub>2</sub> O
10.21	30.56		3.06	37.98	
9.16	35.70		0	37.53	



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### CHLORIDE IN WATER AT 25°.

(Fock — Z. Kryst. Min. 28, 353, '97.)

Grams per Liter Solution.		Mol. per cent Solution.		Sp. Gr. of Solutions.	Mol. per Solid P.	
NH <sub>4</sub> Cl.	KCl.	NH <sub>4</sub> Cl.	KCl.		NH <sub>4</sub> Cl.	KCl.
0.00	311.3	0.00	100.0	1.1807	0.0	100.0
22.81	293.3	9.41	90.59	1.1716	1.21	98.79
35.39	278.7	15.04	84.96	1.1678	2.11	97.89
89.17	273.2	34.26	65.74	1.1591	6.18	93.82
127.8	234.6	46.59	53.44	1.1493	8.90	91.10
147.2	204.2	51.63	48.37	1.1461	10.53	89.47
197.3	157.7	63.56	36.44	1.1391	17.86	82.14
232.5	116.8	73.49	26.51	1.1326	60.20	39.80
244.5	123.0	73.48	26.52	1.1329	76.88	23.12
261.9	111.0	79.10	20.90	1.1245	97.51	2.49
259.0	102.2	82.14	17.86	1.1212	97.79	2.21
278.6	53.16	87.96	12.04	1.1009	98.85	1.15
320.7	31.24	93.45	6.55	1.0912	99.33	0.67
273.5	0.00	100.00	0.00	1.0768	100.0	0.0

The following additional data for the above system are given by Marcus (1911). The results show that  $\text{NH}_4\text{Cl} + \text{KCl}$  form a series of crystals broken by a gap which extends between about 20 and 98 mol.  $\text{NH}_4\text{Cl}$  in the crystals.

Composition of Sat. Solution.				Composition of Solid	
Gms. per 100 Gms. Sat. Sol.		Mols. per 1000 Mols. H <sub>2</sub> O.		Gms. per 100 Gms. Crystals	
NH <sub>4</sub> Cl.	KCl.	NH <sub>4</sub> Cl.	KCl.	NH <sub>4</sub> Cl.	KCl.
5.13	22.29	23.8	74.2	1.21	98.79
7	20.40	32.5	67.9	2.22	97.78
11	18.04	52.2	61.4	4	96
13.73	16.11	65.9	55.5	5.89	94.11
15.46	14.53	74.4	50.2	7.24	92.76
19.54	12.16	96.3	43	11.20	88.80
22.04	10.49	109	37.4	16.90	83.10
21.68	10.40	109	37.4	26.04	73.96
21.95	10.48	109	37.4	97.60	2.40
24.30	6.48	118.2	22.6	98.28	1.72

These authors also give data for the ammonium chloride carnallite diagram at 25°.

(Uyeda, 1912.)

The results as presented by Uyeda show the percentage composition of the dissolved mixture and of the undissolved residue in the several cases, and the quantity of salts dissolved. Mixed crystals were formed over certain ranges of concentration at each temperature.

Data for the cryohydric temperatures and composition of the saturations of mixtures of the chlorides, nitrates and sulfates of ammonium and sodium are given by Mazatto (1891).



**SOLUBILITY OF AMMONIUM CHLORIDE IN AQUEOUS SOLUTIONS OF  
SODIUM CHLORIDE SATURATED WITH CO<sub>2</sub>.**

(Fedotieff.)

t°.	Wt. of 1 cc. Sol.	Per 1000 cc. Solution.				Per 1000 Gms. H <sub>2</sub> O.			
		G. M. NaCl.	G. M. NH <sub>4</sub> Cl.	Gms. NaCl.	Gms. NH <sub>4</sub> Cl.	G. M. NaCl.	G. M. NH <sub>4</sub> Cl.	Gms. NaCl.	Gms. NH <sub>4</sub> Cl.
0	1.069	0.0	4.60	0.0	246.1	0.0	5.57	0.0	298.0
0	1.185	4.04	2.26	236.5	121.0	4.89	2.73	286.4	146.1
15	1.077	0.0	5.29	0.0	283.1	0.0	6.64	0.0	355.0
15	1.097	0.81	4.71	47.5	252.1	1.02	5.91	59.8	316.4
15	1.120	1.68	4.13	98.0	221.7	2.09	5.18	122.4	277.0
15	1.153	2.87	3.38	168.0	180.7	3.57	4.20	208.9	224.7
15	1.175	3.65	2.98	213.5	159.4	4.55	3.72	266.8	198.8
30	...	...	...	...	...	0.0	7.78	0.0	416.4
30	1.166	3.30	3.70	193.0	198.0	4.26	4.77	249.0	255.4
45	...	...	...	...	...	0.0	9.03	0.0	483.7
45	...	...	...	...	...	4.0	6.02	233.9	322.1

**SOLUBILITY OF AMMONIUM CHLORIDE IN AQUEOUS ETHYL ALCOHOL AT 15° AND  
AT 30°.**

Gms. C <sub>2</sub> H <sub>5</sub> OH per 100 Gms. Solvent.	Gms. NH <sub>4</sub> Cl per 100 Gms. Solvent at:	
	15°.	30°.
0	35.2	40.4
20	25	29.7
40	16.8	19
60	9.5	11.1
80	4	5.3
92.3	1.3	...
100	0.6	...

Results at 15° by interpolation from Gerardin (1865), Greenish (1900) and deBruyn (1892). Those at 30° from Bathrick (1896).

100 gms. absolute methyl alcohol dissolve 3.35 gms. NH<sub>4</sub>Cl at 19°.

(deBruyn, 1892.)

100 gms. 98% methyl alcohol dissolve 3.52 gms. NH<sub>4</sub>Cl at 19.5°.

(deBruyn, 1892.)

**SOLUBILITY OF AMMONIUM CHLORIDE IN MIXTURES OF SEVERAL ALCOHOLS  
WITH WATER.**

(Armstrong, Eyre, Hussey and Paddington (1907); and Armstrong and Eyre (1910-11.)

t°.	Gm. Mols. Al- cohol per 1000 Gms. H <sub>2</sub> O.	Gms. NH <sub>4</sub> Cl per 100 Gms. Sat. Solution in:		
		Aq. CH <sub>3</sub> OH.	Aq. C <sub>2</sub> H <sub>5</sub> OH.	Aq. C <sub>2</sub> H <sub>5</sub> OH.
0	0	23	23	23
0	0.25	22.8	22.6	22.7
0	0.50	22.6	22.2	22.3
0	1	22.1	21.5	21.1
0	3	20.5	19	...
25	0	28.3	28.13 (1.0805)	28.3
25	0.25	28.1	28 (1.0780)	28.1
25	0.50	27.9	27.6 (1.0753)	27.5
25	1	27.6	27 (1.0704)	26.6
25	3	26.1	26.5 (1.0528)	...
25	5	...	22.6 (1.0376)	...

(Figures in parentheses show Sp. Gr. of sat. sols.)



## AMMONIUM CHLORIDE

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### SOLUBILITY OF AMMONIUM CHLORIDE IN SEVERAL ALCOHOL MIXTURES (Herz and Kuhn, 1938.)

In Methyl and Ethyl Alcohol.		In Methyl and Propyl Alcohol.		In Propyl and Alcohol.	
Gms. $\text{CH}_3\text{OH}$ per 100 Gms. Solvent.	Gms. $\text{NH}_4\text{Cl}$ per 100 Gms. Sat. Solution.	Gms. $\text{C}_3\text{H}_7\text{OH}$ per 100 Gms. Solvent.	Gms. $\text{NH}_4\text{Cl}$ per 100 Gms. Sat. Solution.	Gms. $\text{C}_3\text{H}_7\text{OH}$ per 100 Gms. Solvent.	Gms. per Sat.
0	0.53	0	2.76	0	
10	0.67	10	2.33	10	
20	0.80	20	1.90	20	
30	0.98	30	1.58	30	
40	1.18	40	1.26	40	
50	1.40	50	1.03	50	
60	1.65	60	0.82	60	
70	1.92	70	0.60	70	
80	2.18	80	0.41	80	
90	2.48	90	0.30	90	
100	2.76	100	0.18	100	

### SOLUBILITY OF AMMONIUM CHLORIDE IN AQUEOUS GLYCEROL SOLUTIONS AT 25°. (Herz and Knoch—Z. anorg. Chem. 45, 263, 267, '05.)

#### In Aqueous Glycerol. (Sp. Gr. of Glycerine 1.255, Impurity about 1.5%.)

Wt. % Glycerine.	$\text{NH}_4\text{Cl}$ per 100 cc. Solution.		Sp. Gr. at 25°/4°.	Vol. % Acetone.	$\text{NH}_4\text{Cl}$ per 100 cc. Solution.	
	Millimols.	Grams.			Millimols.	Grams.
0.	585.1	31.32	1.0793	0	585.1	31.32
13.28	544.6	29.16	1.0947	10	534.1	28.50
25.98	502.9	26.93	1.1127	20	464.6	24.87
45.36	434.4	23.26	1.1452	30	396.7	21.23
54.23	403.5	21.60	1.1606	40	328.5	17.59
83.84	291.4	15.60	1.2225	*46.5 L	283.7	15.19
100.00	228.4	12.23	1.2617	*85.7 U	18.9	1.01
				90	9.4	0.50

\* Between these two concentrations of acetone, the solution separates into two layers. lower layer, U indicates upper layer.

100 cc. anhydrous hydrazine dissolve 75 gms.  $\text{NH}_4\text{Cl}$  at room temp evolution of ammonia. (Welsh and Brode)

### SOLUBILITY OF TETRA ETHYL AMMONIUM CHLORIDE $\text{N}(\text{C}_2\text{H}_5)_4\text{Cl}$ ALSO OF TETRA METHYL AMMONIUM CHLORIDE $\text{N}(\text{CH}_3)_4\text{Cl}$ IN ACETONE

100 cc. sat. solution in  $\text{CH}_3\text{CN}$  contain 29.31 gms.  $\text{N}(\text{C}_2\text{H}_5)_4\text{Cl}$  at 25°.

100 cc. sat. solution in  $\text{CH}_3\text{CN}$  contain 0.265 gms.  $\text{N}(\text{CH}_3)_4\text{Cl}$  at 25°.

(Walden—Z. physik. Chem. 55, 712, '06.)

### SOLUBILITY OF TETRA ETHYL AMMONIUM CHLORIDE IN WATER AND CHLOROFORM.

(Peddle and Turner, 1913.)

100 gms.  $\text{H}_2\text{O}$  dissolve 141.0 gms.  $\text{N}(\text{C}_2\text{H}_5)_4\text{Cl}$  at 25°.

100 gms.  $\text{CHCl}_3$  dissolve 8.24 gms.  $\text{N}(\text{C}_2\text{H}_5)_4\text{Cl}$  at 25°.

### SOLUBILITY OF DIMETHYL AMMONIUM CHLORIDE IN WATER AND CHLOROFORM.

(Hantzsch, 1902.)

100 gms.  $\text{H}_2\text{O}$  dissolve 208 gms. of the salt.

100 gms.  $\text{CHCl}_3$  dissolve 26.9 gms. of the salt (temp. not stated in ab)



## AMMONIUM CHROMATES.

SOLUBILITY IN WATER AT 30°.  
(Schreinemaker — Z. phys. Chem. 55, 80, '06.)

Composition in Wt. per cent of:				Solid Phase.
The Solution.		The Residue.		
% CrO <sub>3</sub>	% NH <sub>3</sub>	% CrO <sub>3</sub>	% NH <sub>3</sub>	
6.933	22.35	...	...	(NH <sub>4</sub> ) <sub>2</sub> CrO <sub>4</sub>
9.966	16.53	47.59	20.44	"
16.973	8.20	...	...	"
22.53	6.37	38.03	12.15	"
27.09	6.87	48.02	12.01	(NH <sub>4</sub> ) <sub>2</sub> CrO <sub>4</sub> + (NH <sub>4</sub> ) <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>
26.19	5.70	47.38	8.81	(NH <sub>4</sub> ) <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>
25.99	5.10	41.56	7.58	"
30.16	3.50	...	...	"
38.89	3.10	61.08	8.80	"
42.44	3.15	59.72	6.75	(NH <sub>4</sub> ) <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> + (NH <sub>4</sub> ) <sub>2</sub> Cr <sub>2</sub> O <sub>10</sub>
44.08	2.27	54.90	4.14	(NH <sub>4</sub> ) <sub>2</sub> Cr <sub>2</sub> O <sub>10</sub>
52.91	1.11	60.88	3.09	"
54.56	1.03	63.07	3.09	(NH <sub>4</sub> ) <sub>2</sub> Cr <sub>2</sub> O <sub>10</sub> + (NH <sub>4</sub> ) <sub>2</sub> Cr <sub>2</sub> O <sub>12</sub>
56.57	0.97	65.70	2.95	(NH <sub>4</sub> ) <sub>2</sub> Cr <sub>2</sub> O <sub>12</sub>
58.87	0.65	69.74	3.24	"
62.48	0.46	71.93	3.10	"
63.60	0.40	73.68	1.18	(NH <sub>4</sub> ) <sub>2</sub> Cr <sub>2</sub> O <sub>12</sub> + CrO <sub>3</sub>
63.66	0.41	71.47	2.07	"
62.94	0.21	...	...	CrO <sub>3</sub>
62.28	0.0	...	...	CrO <sub>3</sub>

100 gms. of the sat. aq. solution contain 28.80 gms. (NH<sub>4</sub>)<sub>2</sub>CrO<sub>4</sub> at 30°.

100 gms. of the sat. aq. solution contain 32.05 gms. (NH<sub>4</sub>)<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> at 30°.

## AMMONIUM CITRATES.

SOLUBILITY IN AQUEOUS SOLUTIONS OF CITRIC ACID AT 30°.  
(van Itallie, 1908.)

(Data read from curve plotted from original results.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	NH <sub>3</sub>		C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	NH <sub>3</sub>	
65	0	C <sub>6</sub> H <sub>8</sub> O <sub>7</sub> ·H <sub>2</sub> O	53	7.5	C <sub>6</sub> H <sub>7</sub> O <sub>7</sub> ·NH <sub>4</sub>
68	0.5	"	56	8.2	"
72	1.3	"	59.1	8.5	C <sub>6</sub> H <sub>7</sub> O <sub>7</sub> ·NH <sub>4</sub> + C <sub>6</sub> H <sub>8</sub> O <sub>7</sub> (NH <sub>4</sub> ) <sub>2</sub>
75	2.3	C <sub>6</sub> H <sub>8</sub> O <sub>7</sub> ·H <sub>2</sub> O + C <sub>6</sub> H <sub>7</sub> O <sub>7</sub> ·NH <sub>4</sub>	54	8.5	C <sub>6</sub> H <sub>8</sub> O <sub>7</sub> (NH <sub>4</sub> ) <sub>2</sub>
70	2.4	C <sub>6</sub> H <sub>7</sub> O <sub>7</sub> ·NH <sub>4</sub>	50	7.9	"
65	2.5	"	45.8	8.4	"
60	2.7	"	47	11.1	"
55	2.8	"	50	12.9	"
52	2.8	"	54.5	14.5	C <sub>6</sub> H <sub>8</sub> O <sub>7</sub> (NH <sub>4</sub> ) <sub>2</sub> + C <sub>6</sub> H <sub>8</sub> O <sub>7</sub> (NH <sub>4</sub> ) <sub>3</sub> ·H <sub>2</sub> O
50	3.6	"	52	15	C <sub>6</sub> H <sub>8</sub> O <sub>7</sub> (NH <sub>4</sub> ) <sub>3</sub> ·H <sub>2</sub> O
49.2	5.1	"	50	16	"
50	6.2	"	48.4	17.9	"

Composition of the solid phases determined by "Rest Method."

(Schreinemakers, Z. anorg. Ch. 37, 207.)

## AMMONIUM CALCIUM FERROCYANIDE.

100 gms. sat. aqueous solution contain 0.258 gm. (NH<sub>4</sub>)<sub>2</sub>CaFe(CN)<sub>6</sub> at 16°.

(Brown.)

AMMONIUM FLUOBORIDE NH<sub>4</sub>3BF<sub>4</sub>.

100 parts of water dissolve 25 parts salt at 16°, and about 97 parts at b. pt.

(Stella — Chem. Techn. Cent. Anz. 7, 459)



## AMMONIUM FORMATE

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### AMMONIUM FORMATE $\text{HCOONH}_4$ , and also Ammonium Acid Formate-

#### SOLUBILITY IN WATER. (Groschuff — Ber. 36, 4351, '03.)

t°.	Gms. $\text{HCOONH}_4$ per 100 Gms. Solution.	Water.	Solid Phase.	t°.	Gms. per 100 Gms. Solution. $\text{HCOONH}_4$ , $\text{HCOOH}$ .	Solid Phase.
-20	41.9	72	$\text{HCOONH}_4$	-6.5	46.7 34.1	$\text{HCOONH}_4, \text{HCOOH}$
0	50.5	102	"	+1.5	49.6 36.2	"
20	58.9	143	"	6	51.3 37.4	"
40	67.1	204	"	8.5	52.1 38	"
60	75.7	311	"	-7	49.6 36.2	$\text{HCOONH}_4$ , labil.
80	84.2	531	"	+13	53 38.6	" stabil.
116 m. pt.				29	55.8 40.7	" "
				39	57.8 42.2	$\text{H}_2\text{O}$ free solution

#### SOLUBILITY OF AMMONIUM FORMATE IN FORMIC ACID SOLUTIONS. (Groschuff.)

30 grams of  $\text{HCOONH}_4$  dissolved in weighed amounts of anhydrous formic acid and cooled to the point at which a solid phase separated.

t°.	Gms. $\text{HCOONH}_4$ per 100 Gms. Solution.	G. M. $\text{HCOONH}_4$ per 100 G. M. $\text{HCOOH}$ .	Solid Phase.	t°.	Gms. $\text{HCOONH}_4$ per 100 Gms. Solution.	G. M. $\text{HCOONH}_4$ per 100 G. M. $\text{HCOOH}$ .	Solid Phase.
-3	35.3	39.9	$\text{HCOONH}_4$	11	50	73	$\text{HCOONH}_4$ , labil.!
+8.5	40.6	49.9	"	39	57.8	100	" stabil.
21.5	50	73	"	78	73.1	199	" "
				116 m. pt.	100	∞	" "

100 gms. 95% Formic Acid dissolve 6.2 gms.  $\text{HCOONH}_4$  at 21°. (Aschan, 1913.)

### AMMONIUM IODATE $\text{NH}_4\text{IO}_3$ .

#### SOLUBILITY IN AQUEOUS IODIC ACID AT 30°. (Meerburg, 1905.)

Gms. per 100 $\text{HIO}_3$ .	Gms. Sat. Sol. $\text{NH}_4\text{IO}_3$ .	Solid Phase.	Gms. per 100 $\text{HIO}_3$ .	Gms. Sat. Sol. $\text{NH}_4\text{IO}_3$ .	Solid Phase.
0	4.20	$\text{NH}_4\text{IO}_3$	24	0.62	$\text{NH}_4\text{IO}_3, 2\text{HIO}_3$
2.54	3.89	"	44.43	0.39	"
4.52	3.83	" + $\text{NH}_4\text{IO}_3, 2\text{HIO}_3$	76.35	0.31	" + $\text{HIO}_3$
6.57	1.94	$\text{NH}_4\text{IO}_3, 2\text{HIO}_3$	76.70	0	$\text{HIO}_3$

### AMMONIUM Per IODATE $\text{NH}_4\text{IO}_4$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 2.7 gms. salt at 16°,  $d_{16} = 1.078$ .

(Barker, 1908.)

### AMMONIUM IODIDE $\text{NH}_4\text{I}$ .

#### SOLUBILITY IN WATER. (Smith and Eastlack, 1916.)

t°.	Gms. $\text{NH}_4\text{I}$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{NH}_4\text{I}$ per 100 Gms. $\text{H}_2\text{O}$ .	Gms. $\text{C}_2\text{H}_5\text{OH}$ per 100 Gms. Solvent.	$d_{25}$ of Sat. Sol.	Gms. $\text{NH}_4\text{I}$ per 100 Gms. Sat. Sol.	Gms. per 100 Gms. Solvent.
-27.5 Eutec.	125.2	40	190.5	0	1.646	64.5	181.9
-20	136	50	199.6	10	1.590	61.7	161.1
-10	145	60	208.9	20	1.525	58.7	142.1
0	154.2	70	218.7	30	1.462	55.5	124.8
10	163.2	80	228.8	40	1.395	52	108.3
15	167.8	100	250.3	50	1.320	48	92.3
20	172.3	120	273.6	60	1.250	43.8	77.9
25	176.8	140	299.2	70	1.168	39	64
30	181.4			80	1.094	33.3	49.9
				90	1.013	27.5	37.9
				100	0.929	20.8	26.3

#### SOLUBILITY IN AQUEOUS ALCOHOL AT 25°. (Seidell, unpublished.)



Tetra Ethyl AMMONIUM IODIDE  $N(C_2H_5)_4I$ .

## SOLUBILITY IN SEVERAL SOLVENTS.

(Walden — Z. physik. Chem. 55, 698, '06.)

Solvent.	Formula.	t°.	Sp. Gr. of Solution.	Gms. $N(C_2H_5)_4I$ per 100.	
				cc. Solution.	Gms. Solution.
Water	$H_2O$	0	1.0470	16.31	15.58
Water	$H_2O$	25	1.1021	36.33 (35.5)	32.9
Methyl Alcohol	$CH_3OH$	0	0.8326	3.7-4.3	4.44
Methyl Alcohol	$CH_3OH$	25	0.8463	10.5 (10.7)	12.29
Ethyl Alcohol	$C_2H_5OH$	0	0.7928	0.348	0.439
Ethyl Alcohol	$C_2H_5OH$	25	0.7844	0.98 (0.88)	1.113
Glycol	$(CH_2OH)_2$	0	1.1039	3.27	2.97
Glycol	$(CH_2OH)_2$	25	1.0904	7.63 (7.55)	7
Acetonitrile	$CH_3CN$	0	0.8163	2.24	2.74
Acetonitrile	$CH_3CN$	25	0.7929	2.97 (3.54)	3.74
Propionitrile	$CH_3CH_2CN$	0	0.8059	0.618	0.767
Propionitrile	$CH_3CH_2CN$	25	0.7830	0.81-1.01	0.99
Benzonitrile	$C_6H_5CN$	25	...	0.467	0.451
Methyl Sulphocyanide	$CH_3SCN$	25	1.0828	4.40	4.06
Ethyl Sulphocyanide	$C_2H_5SCN$	25	1.0012	0.475	0.47
Nitro Methane	$CH_3NO_2$	0	1.1658	3.59	3.004
Nitro Methane	$CH_3NO_2$	25	1.1476	5.38-6.27	4.72
Nitroso Dimethylene	$(CH_3)_2N.NO$	25	1.0059	2.67	2.66
Acetyl Acetone	$CH_3COCH_2COCH_3$	25	...	0.268'	...
Furfural	$C_4H_3O.CO.H$	0	1.1738	3.91	3.33
Furfural	$C_4H_3O.CO.H$	25	1.1692	5.33	4.55
Benzaldehyde	$C_6H_5.CO.H$	25	...	0.43	...
Salicylaldehyde	$C_6H_4.OH.CO.H$	25	...	change- able-17.7	...
Anisaldehyde	$C_6H_4.OCH_3.CO.H$	25	...	0.59	...
Acetone	$(CH_3)_2CO$	0	0.7991	0.174	0.218
Acetone	$(CH_3)_2CO$	25	...	0.249	0.316
Ethyl Acetate	$CH_3COOC_2H_5$	25	...	0.00039	...
Ethyl Nitrate	$C_2H_5ONO_2$	25	1.0984	0.062	0.056
Benzoyl Ethyl Acetate	$C_6H_5.COCH_2.COOC_2H_5$	25	1.1303	0.321	0.284
Dimethyl Malonate	$CH_2(COOC_2H_5)_2$	25	1.1335	0.040	0.035
Methyl Cyan Acetate	$CH_3CNCOOCH_3$	0	1.1341	1.82	1.605
Methyl Cyan Acetate	$CH_3CNCOOCH_3$	25	...	2.83	...
Ethyl Cyan Acetate	$CH_3CNCOOC_2H_5$	0	1.0760	1.057	0.981
Ethyl Cyan Acetate	$CH_3CNCOOC_2H_5$	25	1.0607	1.71	1.41
Nitrobenzene	$C_6H_5NO_2$	25	...	0.504	0.422
Acetophenone	$C_6H_5.COCH_3$	..	...	0.13	0.127
Amyl Alcohol	$C_5H_{11}OH$	..	...	0.071	0.089
Paraldehyde	$(C_2H_4O)_3$	..	...	0.036	0.037
Methyl Formate	$HCOOCH_3$	..	...	0.031	0.032
Bromobenzene	$C_6H_5Br$	..	...	0.009	0.006

(Walden — Z. physik. Chem. 61, 635, 1907-'08.)



# AMMONIUM IODIDE

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## Tetra Methyl AMMONIUM IODIDE $N(CH_3)_4I$ .

### SOLUBILITY IN SEVERAL SOLVENTS.

(Walden — Z. physik. Chem. 55, 708, '06.)

Solvent.	Formula.	t°.	Sp. Gr. of Solution.	Gms. $N(CH_3)_4I$ per 100 —	
				cc. Solution.	Gms. Solution.
Water	$H_2O$	0	1.0188	2.01	1.97
Water	$H_2O$	25	1.0155	5.31–5.89	5.22
Methyl Alcohol	$CH_3OH$	0	0.8025	0.18–0.22	0.22
Methyl Alcohol	$CH_3OH$	25	0.7920	0.38–0.42	0.48
Ethyl Alcohol	$C_2H_5OH$	25	0.7894	0.09	...
Glycol	$(CH_2OH)_2$	0	...	1.014	...
Glycol	$(CH_2OH)_2$	25	1.0678	0.240	0.224
Acetonitril	$CH_3CN$	25	...	0.650	...
Nitro Methane	$CH_3NO_2$	0	1.1387	0.25–0.32	0.22
Nitro Methane	$CH_3NO_2$	25	1.1285	0.34–0.38	0.21
Acetone	$(CH_3)_2CO$	0	...	0.118	...
Acetone	$(CH_3)_2CO$	25	...	0.187	...
Salicyl Aldehyde	$C_6H_4.OH.CO$	0	1.1492	0.302	0.263
Salicyl Aldehyde	$C_6H_4.OH.CO$	25	1.1379	0.510	0.484

Very exact determinations of the solubility of tetra methyl ammonium iodide in aqueous solutions of KOH and of  $NH_4OH$  at 25° are given by Hill (1917).

## Tetra Propyl AMMONIUM IODIDE $N(C_3H_7)_4I$ .

### SOLUBILITY IN SEVERAL SOLVENTS.

(Walden — Z. physik. Chem. 55, 709, '06.)

Solvent.	Formula.	t°.	Sp. Gr. of Solution.	Gms. $N(C_3H_7)_4I$ per 100.	
				cc. Solution	Gms. Solution.
Methyl Alcohol	$CH_3OH$	0	0.9756	40.92	41.94
Methyl Alcohol	$CH_3OH$	25	1.0187	56.42	55.37
Ethyl Alcohol	$C_2H_5OH$	0	0.8349	6.5–6.8	8.14
Ethyl Alcohol	$C_2H_5OH$	25	0.8716	19.88–20.29	23.28
Acetonitrile	$CH_3CN$	0	0.8553	13.03	15.24
Acetonitrile	$CH_3CN$	25	0.8584	18.69	21.77
Propionitrile	$C_2H_5CN$	0	0.8280	6.37	7.66
Propionitrile	$C_2H_5CN$	25	0.8191	9.65	10.29
Benzonitrile	$C_6H_5CN$	25	1.0199	8.44	8.35
Nitro Methane	$CH_3NO_2$	0	1.181	14.79	12.52
Nitro Methane	$CH_3NO_2$	25	1.158	22.24	19.21
Nitro Benzene	$C_6H_5NO_2$	25	1.193	5.71	4.79
Benzaldehyde	$C_6H_5COH$	0	1.0581	7.06	6.67
Benzaldehyde	$C_6H_5COH$	25	1.0549	9.87	9.35
Anisaldehyde	$C_6H_5.OCH_3.CO$	0	1.1114	5.60	5.04
Anisaldehyde	$C_6H_5.OCH_3.CO$	25	1.1004	6.75	6.14
Salicylaldehyde	$C_6H_5.OH.CO$	25	...	39.28	...
Ethyl nitrite	$C_2H_5NO_2$	0	1.1207	0.522	0.466
Ethyl nitrite	$C_2H_5NO_2$	25	1.1025	0.653	0.592
Dimethyl Malonate	$CH_2(COOCH_3)_2$	0	1.1532	0.298	0.259
Dimethyl Malonate	$CH_2(COOCH_3)_2$	25	1.1345	0.320	0.282
Acetone	$(CH_3)_2CO$	0	0.8259	2.692	4.65
Acetone	$(CH_3)_2CO$	25	0.8049	3.944	4.90
Ethyl Acetate	$CH_3COOC_2H_5$	25	0.8975	0.0063	0.007
Ethyl Bromide	$C_2H_5Br$	25	...	...	0.187

(Walden — Z. physik. Chem. 61, 639, 1907-'08)



SOLUBILITY OF TETRA AMYL, TETRA ETHYL AND TETRA  $\alpha$  PROPYL AMMONIUM IODIDES IN WATER AND IN CHLOROFORM AT 25°. (Peddle and Turner, 1913.)

Solvent.	Gms. Each Salt (Determined Separately), per 100 Gms. Solvent.		
	$N(C_4H_9)_4I.$	$N(C_2H_5)_4I.$	$\alpha N(C_3H_7)_4I.$
Water	0.74	45	18.64
$CHCl_3$	210.8	1.55	54.56

Freezing-point data for mixtures of tetra methyl ammonium iodide and iodine, and for phenyltrimethyl ammonium iodide and iodine are given by Olivari (1908).

#### AMMONIUM Iridium CHLORIDES.

SOLUBILITY IN WATER AT 19°. (Delepine, 1903.)

Name of Salt.	Formula.	Gms. per 100 Gms. $H_2O$ .
Ammonium iridium chloride	$(NH_4)_2IrCl_6$	0.77
Diammonium aquo penta chloro iridite	$IrCl_5(H_2O)(NH_4)_2$	15.4
Triammonium hexa chloro iridite	$IrCl_6(NH_4)_3 + H_2O$	10.5

#### AMMONIUM Iodo MERCURATE $2NH_4I.HgI_2.H_2O$ .

100 gms. of the saturated aqueous solution contain 4.5 gms.  $NH_4$ , 22.6 gms.  $Hg$  and 62.3 gms.  $I$  at 26°, sp. gr. = 2.98. (Duboin, 1905.)

#### AMMONIUM Tetra MOLYBDATE $(NH_4)_2O.4MoO_3.2H_2O$ .

100 gms.  $H_2O$  dissolve 3.52 gms. salt at 15° ( $d = 1.03$ ), 3.67 gms. at 18° ( $d = 1.04$ ) and 4.60 gms. at 32° ( $d = 1.05$ ). (Wempe, 1912.)

#### AMMONIUM Phospho MOLYBDATE $(NH_4)_3PO_4.14MoO_3.4H_2O$ .

SOLUBILITY IN WATER AND AQUEOUS SOLUTIONS AT 15°. (de Lucchi, 1910.)

Solvent.	Gms. Salt per 1000 Gms. Solvent.
Water	0.238
5 per cent aqueous $NH_4NO_3$ solution	0.137
1 per cent aqueous $HNO_3$ solution	0.203

#### AMMONIUM NITRATE $NH_4NO_3$ .

SOLUBILITY IN WATER.

(Schwarz—Ostwald's Lehrbuch, 2d ed. p. 425; Müller and Kaufmann—Z. physik. Chem. 42, 497, '01-'02.)

t°.	Sp. Gr. Solution.	G. Mols. $NH_4NO_3$ per 100 Mols. $H_2O$ .	Gms. $NH_4NO_3$ per 100 Gms.		Solid Phase.
			Solution.	Water.	
0	...	26.63	54.19	118.3	$NH_4NO_3$ , rhomb. $\beta$
12.2	1.2945	34.50	60.53	153.4	"
20.2	1.3116	43.30	65.80	192.4	"
25.0	1.3197	48.19	68.17	214.2	"
30.0	1.3299	54.40	70.73	241.8	"
32.1	1.3344	57.60	71.97	256.9	$NH_4NO_3$ , rhomb. $\beta$ + rhomb. $\alpha$
35.0	1.3394	59.80	72.64	265.8	$NH_4NO_3$ , rhomb. $\alpha$
40.0	1.3464	66.80	74.82	297.0	"
50.0	...	77.41	77.49	344.0	"
60.0	...	94.73	80.81	421.0	"
70.0	...	112.30	83.32	499.0	"
80.0	...	130.50	85.25	580.0	"
90.0	...	166.50	88.08	740.0	$NH_4NO_3$ , rhombohedral?
100.0	...	196.00	89.71	871.0	"

SOLUBILITIES OF MIXTURES OF AMMONIUM NITRATE AND OTHER SALTS. (Rüdorff—Mulder.)

100 gms.  $H_2O$  dissolve 162.9 gms.  $NH_4NO_3$  + 77.1 gms.  $NaNO_3$  at 16° R.  
 100 gms.  $H_2O$  dissolve 88.8 gms.  $NH_4NO_3$  + 40.6 gms.  $KNO_3$  at 9° M.  
 100 gms.  $H_2O$  dissolve 101.3 gms.  $NH_4NO_3$  + 6.2 gms.  $Ba(NO_3)_2$  at 9° M.



# AMMONIUM NITRATE

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## SOLUBILITY OF AMMONIUM NITRATE IN AMMONIA.

(Kurloff—Z. physic. Chem. 25, 109, '98.)

t°.	Gms. $\text{NH}_4\text{NO}_3$ .	Gms. $\text{NH}_3$ .	Mols. $\text{NH}_4\text{NO}_3$ per 100 Mols. $\text{NH}_4\text{NO}_3 + \text{NH}_3$ .	t°.	Gms. $\text{NH}_4\text{NO}_3$ .	Gms. $\text{NH}_3$ .	Mols. $\text{NH}_4\text{N}$ per 100 Mols. $\text{NH}_4\text{NO}_3 + \text{NH}_3$ .
-80	0	100	0.0	33.3	0.9358	0.2352	45.9
-60	1.3918	4.4327	6.25	35.9	0.7746	0.1857	47.0
-44.5	0.9526	1.2457	13.9	68.8	4.2615	0.7747	53.8
-30	0.8308	0.3700	32.3	94.0	0.6439	0.0665	67.3
-10.5	0.9675	0.3515	36.9	190.8	0.7578	0.0588	74.2
0	0.7600	0.2607	38.3	168.0	...	...	100.0

t° = temperature of equilibrium between solution and solid phase

## SOLUBILITY OF AMMONIUM NITRATE IN AQUEOUS SOLUTIONS OF AMMONIUM SULFATE AND VICE VERSA.

(Massinik, 1916, 1917.)

Results at 0°. (de Waal, 1910.)			Results at 30°. (Schreinemakers and Haenen, 1910.)			Results at 70°. (de Waal, 1910.)		
Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{NH}_4\text{NO}_3$ ( $\text{NH}_4$ ) <sub>2</sub> SO <sub>4</sub> .			$\text{NH}_4\text{NO}_3$ ( $\text{NH}_4$ ) <sub>2</sub> SO <sub>4</sub> .			$\text{NH}_4\text{NO}_3$ ( $\text{NH}_4$ ) <sub>2</sub> SO <sub>4</sub> .		
54.19	0	$\text{NH}_4\text{NO}_3$	70.1	0	$\text{NH}_4\text{NO}_3$	84.03	0	$\text{NH}_4\text{NO}_3$
49.12	6	"	67.63	2.38	"	81.38	2.41	"
45.99	9.53	$\text{NH}_4\text{NO}_3 + 1.3$	66.93	3.46	$\text{NH}_4\text{NO}_3 + 1.3$	81.01	2.45	$\text{NH}_4\text{NO}_3 + 1$
31.61	19.5	1.3	63.84	4.06	1.3	80.25	2.68	1.3
30.87	20.43	1.3+1.2	58.06	8.22	1.3+1.2	76.01	3.96	"
31.04	20.4	1.2	52.75	11.42	1.2	73.48	5.14	1.3+1.2
29.81	21.33	"	49.80	13.27	" + ( $\text{NH}_4$ ) <sub>2</sub> SO <sub>4</sub>	71.58	5.82	1.2
29.58	41.64	1.2 + ( $\text{NH}_4$ ) <sub>2</sub> SO <sub>4</sub>	37.20	19.48	( $\text{NH}_4$ ) <sub>2</sub> SO <sub>4</sub>	70.15	6.71	1.2 + ( $\text{NH}_4$ ) <sub>2</sub> SO <sub>4</sub>
5.61	37.89	( $\text{NH}_4$ ) <sub>2</sub> SO <sub>4</sub>	19.91	28.83	"	11.10	40.81	( $\text{NH}_4$ ) <sub>2</sub> SO <sub>4</sub>
0	41.4	"	12.05	34.7	"	0	47.81	"
			0	44.1	"			

1.3 = ( $\text{NH}_4$ )<sub>2</sub>SO<sub>4</sub>.3 $\text{NH}_3\text{NO}_3$ . 1.2 = ( $\text{NH}_4$ )<sub>2</sub>SO<sub>4</sub>.2 $\text{NH}_4\text{NO}_3$ .

Freezing-point lowering data for mixtures of ammonium nitrate and ammonium sulfate are given by Bogitch (1915).

## SOLUBILITY OF AMMONIUM NITRATE IN NITRIC ACID.

(Groschuff—Ber. 37, 1488, '04.)

Determinations by the "Synthetic Method," see Note, page 16.

t°.	Gms. $\text{NH}_4\text{NO}_3$ per 100 Gms. Sol.	Mols. $\text{NH}_4\text{NO}_3$ per 100 Mols. $\text{HNO}_3$ .	Solid Phase.	t°.	Gms. $\text{NH}_4\text{NO}_3$ per 100 Gms. Sol.	Mols. $\text{NH}_4\text{NO}_3$ per 100 Mols. $\text{HNO}_3$ .	Solid Phase.
8	21.1	21.1	$\text{NH}_4\text{NO}_3 \cdot \text{HNO}_3$	11.0	51.7	84.3	$\text{NH}_4\text{NO}_3 \cdot \text{HNO}_3$
23	28.7	31.6	" a	12.0	54.7	95.1	" 1
29.5 m.pt.	38.8	50.0	"	11.5	57.6	108.0	"
27.5	44.6	63.4	" b	11.5	54.0	92.4	$\text{NH}_4\text{NO}_3$ 1
23.5	49.4	76.8	"	17.0	54.7	95.1	" a
17.5	54.0	92.4	"	27.0	56.2	101.0	"
16.5	54.3	93.5	"	49.0	60.4	120.0	"
4.0	45.8	66.7	$\text{NH}_4\text{NO}_3 \cdot \text{HNO}_3$ labil	79.0	68.1	168.0	"

a = solution in  $\text{HNO}_3$ , b = solution in  $\text{NH}_4\text{NO}_3$ .



SOLUBILITY OF AMMONIUM TRI-NITRATE IN WATER.  
(Greschuff.)

t°.	Gms. $\text{NH}_4\text{NO}_3$ per 100 Gms. Solution.	Gms. $\text{HNO}_3$ per 100 Gms. Solution.	Mols. $\text{NH}_4\text{NO}_3^*$ per 100 Mols. $\text{H}_2\text{O}$ .	Mols. $\text{NH}_4\text{NO}_3$ per 100 total Mols. Solution.	Solid Phase.
- 8	34.2	53.9	64.3	22	$\text{NH}_4\text{NO}_3 \cdot 2\text{HNO}_3$
- 2.5	34.8	54.8	75.1	23.1	"
+ 3	35.4	55.8	90	24.3	"
8.5	36.6	56.9	113	25.7	"
19.5	37.4	58.9	225	29	"
25	38.1	60	450	31	"
29.5 m. pt.	38.8	61.2	$\infty$	33	"

\* or  $\text{NH}_4\text{NO}_3 \cdot 2\text{HNO}_3$ .

SOLUBILITY OF MIXTURES OF AMMONIUM NITRATE AND SILVER NITRATE IN  
WATER AT VARIOUS TEMPERATURES.  
(Schreinemakers and deBaat, 1910.)

t°.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
	$\text{AgNO}_3$ $\text{NH}_4\text{NO}_3$			$\text{AgNO}_3$ $\text{NH}_4\text{NO}_3$	
- 7.3	47.1 0	Ice + rb. $\text{AgNO}_3$	109.6	67.9 32.1	D + rb. $\text{AgNO}_3$
- 10.7	44.52 8.43	"	0	22.13 44.87	D + rb. $\text{NH}_4\text{NO}_3$
- 14.9	42 16.8	Ice + D + rb. $\text{AgNO}_3$	18	27.07 49.22	"
- 14.8	39.51 18.79	" + D	30	29.76 52.50	"
- 18.7	15.99 37.3	" + D + rb. $\text{NH}_4\text{NO}_3$	$\pm 32$	...	{ D + rb. $\text{NH}_4\text{NO}_3$ + α + rb. $\text{NH}_4\text{NO}_3$
- 17.4	0 41.2	" + rb. $\text{NH}_4\text{NO}_3$	40	32.63 52.22	D + α rb. $\text{NH}_4\text{NO}_3$
0	50.36 19.59	D + rb. $\text{AgNO}_3$	55	36.6 52.38	"
18	55.36 22.06	"	85.4	...	{ D + rb. $\text{NH}_4\text{NO}_3$ + rbd. $\text{NH}_4\text{NO}_3$
30	58.89 23.42	"	101.5	47.5 52.5	D + rbd. $\text{NH}_4\text{NO}_3$
55	63.32 26.12	"			

D =  $\text{NH}_4\text{NO}_3 \cdot \text{AgNO}_3$ . rb. = rhombic. rbd. = rhombohedral.

SOLUBILITY OF AMMONIUM NITRATE IN AQUEOUS SOLUTIONS OF SILVER  
NITRATE AND VICE VERSA AT 30°.  
(Schreinemakers and deBaat, 1910.)

Gms. per 100 Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
$\text{AgNO}_3$ $\text{NH}_4\text{NO}_3$		$\text{AgNO}_3$ $\text{NH}_4\text{NO}_3$	
0 70.1	$\text{NH}_4\text{NO}_3$	45.85 34.47	D
12.51 63.59	"	52.45 28.86	"
21.31 58.64	"	57.93 24.33	"
27.75 54.12	"	58.88 23.42	D + $\text{AgNO}_3$
29.76 52.5	$\text{NH}_4\text{NO}_3 + \text{D}$	63.27 15.62	$\text{AgNO}_3$
35.62 45.44	D	69.08 6.59	"
41.09 39.60	"	73 0	"

D =  $\text{NH}_4\text{NO}_3 \cdot \text{AgNO}_3$ .

Results are also given by Schreinemakers (1908-09) for the reciprocal solubility of ammonium nitrate and silver nitrate in aqueous alcohol solutions at 30°.

100 cc. anhydrous hydrazine dissolve 78 gms.  $\text{NH}_4\text{NO}_3$  at room temp. with decomp. (Welsh and Broderson, 1915.)

Freezing-point data for mixtures of ammonium nitrate and silver nitrate are given by Flavitzkii (1909) and by Zawidzki (1904). The eutectic is at 102.4° and 30.9 Mol. %  $\text{AgNO}_3$ . Results for  $\text{NH}_4\text{NO}_3 + \text{TlNO}_3$  are given by Boks (1902).



RECIPROCAL SOLUBILITY OF AMMONIUM NITRATE AND SODIUM NITRATE IN  
WATER AT 0°, 15° AND 30°.  
(Fedotieff and Koltunoff, 1914.)

t°.	Sp. Gr. Sat. Sol.	Gms. per 100 Gms. H <sub>2</sub> O.		t°.	Sp. Gr. Sat. Sol.	Gms. per 100 Gms. H <sub>2</sub> O.	
		NH <sub>4</sub> NO <sub>3</sub> .	NaNO <sub>3</sub> .			NH <sub>4</sub> NO <sub>3</sub> .	NaNO <sub>3</sub> .
0	1.354	0	73.33	15	1.429	155.3	75.38
0	1.407	105.5	66	15	1.405	156.1	60.76
0	1.264	118.4	0	15	1.364	159	36.50
15	1.375	0	83.9	15	1.350	160	27.79
15	1.386	24.03	81.21	15	1.330	162.3	17.63
15	1.392	42.81	79.34	15	1.298	167.4	0
15	1.401	64.6	78.06	30	1.401	0	96.12
15	1.417	110.9	75.81	30	1.450	220.8	88.31
15	1.428	152	75.35	30	1.329	232.6	0

SOLUBILITY OF AMMONIUM NITRATE IN AQUEOUS ETHYL ALCOHOL.  
(Fleckenstein — Physik. Z., 6, 419, '05.)

t°	Grams of NH <sub>4</sub> NO <sub>3</sub> Dissolved per 100 Grams Aq. Alcohol of (Wt. %):					
	100%.	86.77%.	76.12%.	51.65%.	25.81%.	0%.
20	2.5	11	23	70	140	195
30	4	14	32	90	165	230
40	5	18	43	115	196	277
50	6	24	55	144	244	365
60	7.5	30	70	183	320	...
70	9	41	93	230	...	...
80	10.5	56	...	...	...	...

NOTE. — The figures in the preceding table were read from curves shown in the abridged report of the work, and are, therefore, only approximately correct. Determinations of the solubility in methyl alcohol solutions were also made but not quoted in the abstract. The "Synthetic Method" (see Note, page 16) was used.

100 grams absolute ethyl alcohol dissolve 4.6 grams NH<sub>4</sub>NO<sub>3</sub> at 14° and 3.1 grams at 20.5°.

100 grams absolute methyl alcohol dissolve 14.6 grams NH<sub>4</sub>NO<sub>3</sub> at 14°, 16.2 grams at 18.5° and 17.1 grams at 20.5°.

(Schiff and Monsacchi — Z. physik. Chem., 21, 277, '96; at 20.5° de Bruyn — *Ibid.*, 20, 783, '92.)

SOLUBILITY OF AMMONIUM NITRATE IN AQUEOUS ETHYL AND METHYL  
ALCOHOLS AND IN A MIXTURE OF THE TWO AT 30°.  
(Schreinemakers, 1908-09.)

Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
H <sub>2</sub> O.	C <sub>2</sub> H <sub>5</sub> OH.	NH <sub>4</sub> NO <sub>3</sub> .	H <sub>2</sub> O.	CH <sub>3</sub> OH.	NH <sub>4</sub> NO <sub>3</sub> .	H <sub>2</sub> O.	*CH <sub>3</sub> OH + C <sub>2</sub> H <sub>5</sub> OH.	NH <sub>4</sub> NO <sub>3</sub> .
0	96.4	3.6	0	83.3	16.7	3.4	84.9	11.7
5	89.6	6.5	5	74.8	21.3	5	82.9	12.3
10	80.4	10.7	10	63.8	27.1	10	74.6	16.4
15	68.6	17	15	50.7	35	15	63.5	24
20	53.5	26.8	20	35.2	46.3	20	48.2	35.1
25	32.5	44.8	25	19.8	59	25	22.4	54
29.9	0	70.1	29.9	0	70.1	29.9	0	70.1

\* Weight per cent CH<sub>3</sub>OH = 51.7, C<sub>2</sub>H<sub>5</sub>OH = 48.3.

Additional determinations of the solubility of ammonium nitrate in aqueous ethyl alcohol solutions at 0°, 30° and 70° are given by deWaal (1910). At certain concentrations at 67.5° the solutions separate into two layers.



**AMMONIUM Magnesium NITRATE**  $2\text{NH}_4\text{NO}_3 \cdot \text{Mg}(\text{NO}_3)_2$ .

100 parts water dissolve 10 parts salt at  $12.5^\circ$ .

(Foucroy.)

**AMMONIUM Manganic MOLYBDATE**  $5(\text{NH}_4)_2\text{MoO}_4 \cdot \text{Mn}_2(\text{Mo}_2\text{O}_7)_3 \cdot 12\text{H}_2\text{O}$ .

100 parts water dissolve 0.98 part salt at  $17^\circ$ .

(Struve—J. pr. Chem., 61, 460, '54.)

**AMMONIUM OLEATE**  $\text{C}_{17}\text{H}_{35}\text{COONH}_4$ .

SOLUBILITY IN SEVERAL SOLVENTS.

(Falcioni, 1910.)

Solvent.	Gms. $\text{C}_{17}\text{H}_{35}\text{COONH}_4$ dissolved per 100 cc. solvent:			
	31 at $0^\circ$	59 at $10^\circ$	100 at $50^\circ$	
Absolute Alcohol	31 at $0^\circ$	59 at $10^\circ$	100 at $50^\circ$	
75 per cent Alcohol	...	8.2 at $20^\circ$	10.86 at $30^\circ$	
1 part Alcohol + 2 parts Ether	...	9.45 at $15^\circ$	16.9 at $20^\circ$	
Acetone	...	4.7 at $15^\circ$	...	

**AMMONIUM OXALATE**  $(\text{COONH}_4)_2 \cdot \text{H}_2\text{O}$ .

SOLUBILITY IN WATER.

(Ar. curve from results of Engel, 1888; Foote and Andrew, 1905; Woudstra, 1912; Colani, 1916.)

$t^\circ$ .	Gms. $(\text{COONH}_4)_2$ per 100 Gms. Sat. Solution.	$t^\circ$ .	Gms. $(\text{COONH}_4)_2$ per 100 Gms. Sat. Solution.
0	2.1	25	4.8
10	3	30	5.6
15	3.5	40	7.4
20	4.2	50	9.3

SOLUBILITY IN AQUEOUS SOLUTIONS OF OXALIC ACID.

(Woudstra, 1912.)

Results at $30^\circ$ . (Interpolated from Original.)			Results at $45^\circ$ .		
Gms. per 100 Gms. Sat. Sol. $(\text{COONH}_4)_2$ .	Gms. per 100 Gms. Sat. Sol. $(\text{COOH})_2$ .	Solid Phase.	Gms. per 100 Gms. Sat. Sol. $(\text{COONH}_4)_2$ .	Gms. per 100 Gms. Sat. Sol. $(\text{COOH})_2$ .	Solid Phase.
0.14	12.36	A	0.22	21.22	A
0.28	12.78	A+T	0.31	21.31	"
0.30	12	T	0.53	20.54	A+T
0.39	10	"	0.56	21.23	T
0.47	8	"	0.61	20.55	"
0.52	7	"	0.54	20.92	"
0.68	6	"	0.79	16.44	"
1	5	"	1.23	12.88	"
2	3.96	"	7.16	7.98	"
3	3.61	"	3.54	5.83	"
4	3.60	"	5.65	5.67	"
5	3.81	"	6.72	5.95	"
5.98	4.21	T+A. O.	8.74	6.53	T+A. O.
7	3.63	A. O.	8.93	6.27	A. O.
8.19	3.36	A. O.+N. O.	9.04	6.14	"
7	2.32	N. O.	12.38	5	A. O.+N. O.
6	1.02	"	8.31	3.04	N. O.
5.53	0.22	"	9.59	1.45	"

A = Oxalic Acid  $(\text{COOH})_2 \cdot \text{H}_2\text{O}$ .

A. O. = Acid Ammonium Oxalate  $(\text{COO})_2\text{H} \cdot \text{NH}_4 \cdot \text{H}_2\text{O}$ .

T = Ammonium tetroxalate  $(\text{COOH})_2(\text{COO})_2\text{H} \cdot \text{NH}_4 \cdot 2\text{H}_2\text{O}$ .

N. O. = Neutral Ammonium Oxalate  $(\text{COONH}_4)_2 \cdot \text{H}_2\text{O}$ .

Additional data for this system at  $25^\circ$  are given by Walden (1905), and at  $0^\circ$ , by Engel (1888).



## AMMONIUM OXALATE

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### SOLUBILITY IN WATER OF MIXTURES OF AMMONIUM OXALATE AND:

Other Oxalates at 25°. (Foote and Andrew, 1905.)			Other Ammonium Salts. (Colani, 1916.)		
Gms. per 100 Gms. Sat. Solution.		t°.	Gms. per 100 Gms. Sat. Solution.		
2.79	(COONH <sub>4</sub> ) <sub>2</sub> ·H <sub>2</sub> O	+25.96	(COOK) <sub>2</sub> ·H <sub>2</sub> O	15	0.14 (COONH <sub>4</sub> ) <sub>2</sub> + 26.35 NH <sub>4</sub> C
4.8	"	+5.75	(COOLi) <sub>2</sub>	50	0.67 " + 32.55 "
5.45	"	+0.59	(COO) <sub>2</sub> Mg·2H <sub>2</sub> O	18	0.11 " + 42.43 (NH <sub>4</sub> ) <sub>2</sub>
6.19	"	+1.45	(COO) <sub>2</sub> Zn·2H <sub>2</sub> O	50	0.65 " + 45.92 "
5.06	"	+0.28	(COO) <sub>2</sub> Cd·3H <sub>2</sub> O	19	0.085 " + 62.26 NH <sub>4</sub> N
				50	0.35 " + 72.11 "

Both salts in excess in every case. No double salts formed.

### SOLUBILITY OF AMMONIUM OXALATE AND OF AMMONIUM THORIUM OXALATE IN WATER AT 25°.

(James, Whittemore and Holden, 1914.)

The mixtures were constantly agitated for periods varying from many weeks to several months.

Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.	Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.
(NH <sub>4</sub> ) <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .	Th(C <sub>2</sub> O <sub>4</sub> ) <sub>2</sub> .		(NH <sub>4</sub> ) <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .	Th(C <sub>2</sub> O <sub>4</sub> ) <sub>2</sub> .	
5.25	0	(NH <sub>4</sub> ) <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	29.47	39.10	2.1.7 + 2.1.2
6.04	1.54	"	23.04	29.87	2.1.2
7.78	4.51	"	16.84	21.18	"
10.37	8.87	"	13.27	15.96	"
15.46	16.89	"	8.13	9.13	"
21.47	26.37	"	5.36	5.63	"
28.18	36.54	" + 2.1.7	1.70	1.42	"

2.1.7 = 2Th(C<sub>2</sub>O<sub>4</sub>)<sub>2</sub>·(NH<sub>4</sub>)<sub>2</sub>C<sub>2</sub>O<sub>4</sub>·7H<sub>2</sub>O; 2.1.2 = 2Th(C<sub>2</sub>O<sub>4</sub>)<sub>2</sub>·(NH<sub>4</sub>)<sub>2</sub>C<sub>2</sub>O<sub>4</sub>·2H<sub>2</sub>O  
 100 gms. 95% formic acid dissolve 6.2 gms. (NH<sub>4</sub>)<sub>2</sub>C<sub>2</sub>O<sub>4</sub> at 21°. (Aschan, 19  
 100 cc. anhydrous hydrazine dissolve 44 gms. (NH<sub>4</sub>)<sub>2</sub>C<sub>2</sub>O<sub>4</sub> at room temperature  
 with evolution of ammonia. (Welsh and Broderson, 19

## AMMONIUM PALMITATE C<sub>16</sub>H<sub>31</sub>O<sub>2</sub>NH<sub>4</sub>.

### SOLUBILITY IN SEVERAL SOLVENTS.

(Falcioni, 1910.)

t°.	Gms. C <sub>16</sub> H <sub>31</sub> O <sub>2</sub> NH <sub>4</sub> per 100 c.c. of:				
	Absolute Alcohol.	75% Alcohol.	50% Alcohol.	Mixture of 1 Pt. Alcohol + 2 Parts Ether.	Acetone.
0	0.5	...	...	...	...
10	0.7	1.78	...	0.37 (13°)	0.2 (13°)
20	1.4	4.33	5.33	0.29	...
30	...	11.02	...	...	...
40	4.5	14.84	6.69	...	...
50	11	...	...	...	...

## AMMONIUM PHOSPHATES (NH<sub>4</sub>)<sub>3</sub>PO<sub>4</sub>, (NH<sub>4</sub>)<sub>2</sub>HPO<sub>4</sub>, and NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub>.

100 gms. H<sub>2</sub>O dissolve 131 gms. (NH<sub>4</sub>)<sub>2</sub>HPO<sub>4</sub> at 15°, d<sub>15</sub> sat. sol. = 1.343.  
 (Greenish and Smith, 1901.)

Data for the solubility of mono ammonium phosphate in anhydrous and aqueous ortho phosphoric acid, determined by the synthetic method, are given by Parravano and Mieli, 1908.



SOLUBILITY OF AMMONIUM PHOSPHATES IN AQUEOUS SOLUTIONS OF ORTHO  
PHOSPHORIC ACID AT 25°.

(Parker, 1914.)

Gms. per 100 Gms. Sat. Solution.		Solid Phase.	Gms. per 100 Gms. Sat. Solution.		Solid Phase.
H <sub>3</sub> PO <sub>4</sub> .	NH <sub>3</sub> .		H <sub>3</sub> PO <sub>4</sub> .	NH <sub>3</sub> .	
4.1	22.6	(NH <sub>4</sub> ) <sub>3</sub> PO <sub>4</sub> ·3H <sub>2</sub> O	40	9	NH <sub>4</sub> H <sub>2</sub> PO <sub>4</sub>
4.4	18.4	"	30	5.4	"
10	13.1	"	20.6	4	"
20	7	"	30	3.8	"
30	7.7	"	40	4	"
34.4	10	(NH <sub>4</sub> ) <sub>3</sub> PO <sub>4</sub> ·3H <sub>2</sub> O + (NH <sub>4</sub> ) <sub>2</sub> HPO <sub>4</sub>	50	4.2	"
40	10.2	(NH <sub>4</sub> ) <sub>2</sub> HPO <sub>4</sub>	60.6	4.4	"
48.2	11.6	(NH <sub>4</sub> ) <sub>2</sub> HPO <sub>4</sub> + NH <sub>4</sub> H <sub>2</sub> PO <sub>4</sub>			

The original figures have been calculated to grams, plotted on cross-section paper and the above table read from the curve.

Data for this system are also given by D'Ans and Schreiner (1910). The agreement is satisfactory except for the (NH<sub>4</sub>)<sub>3</sub>PO<sub>4</sub>·3H<sub>2</sub>O end of the curve, for which much lower values for the NH<sub>3</sub> component are given by D'Ans and Schreiner.

AMMONIUM Magnesium PHOSPHATE NH<sub>4</sub>MgPO<sub>4</sub>·6H<sub>2</sub>O and 1H<sub>2</sub>O.

SOLUBILITY IN WATER AND SALT SOLUTIONS.

(Bube, 1910.)

The solutions were saturated in 7-16 liter flasks. The stirrer was introduced through a mercury sealed connection, in order to prevent loss of moisture or ammonia during the long periods required for saturation. Great care was exercised to eliminate errors of manipulation. Large volumes of the saturated solutions were used for analysis. In the cases where equilibrium was approached from above (designated by \*, in table below) the mixtures were heated to about 90° for  $\frac{1}{2}$  hour, and then cooled while being continually stirred for 4-5 hours at 50°, and then in a thermostat at 25° for the remaining period shown.

Solvent.	t°.	Time for Saturation.	Gms. per 100 Gms. Sat. Sol.			Solid Phase.
			Mg.	P <sub>2</sub> O <sub>5</sub> .	NH <sub>3</sub> .	
Water	25°	69 hrs.	0.0808	0.0965	...	Mixed Hydrates
"	25	9 days	0.0867	0.0992	...	"
"	25	14 "	0.1352	0.1333	0.1301	"
"	22.7	17 hrs.*	0.1076	0.1084	0.1040	Monohydrate
1 M NH <sub>4</sub> Cl	25	20 days	0.3129	0.3057	...	Mixed Hydrates
$\frac{1}{1.3}$ M NH <sub>4</sub> Cl + 1 M NH <sub>3</sub>	25.2	16 hrs.*	0.0249	0.02025	...	Monohydrate
0.2 Mol. MgCl <sub>2</sub> per liter H <sub>2</sub> O	25	27 days	...	0.0206	...	Mixed Hydrates
0.3 " " "	25.2	16 hrs.*	...	0.0512	...	Monohydrate
$\frac{1}{1.3}$ Mol. (NH <sub>4</sub> ) <sub>2</sub> HPO <sub>4</sub> per liter H <sub>2</sub> O	24.25	...	0.1229	...	...	"

SOLUBILITY OF AMMONIUM MAGNESIUM PHOSPHATE IN SEVERAL SOLVENTS.

(Wenger, 1911.)

Gms. NH<sub>4</sub>MgPO<sub>4</sub> per 100 Gms. Solvent in:

t°.	Water.	Aq. 5% NH <sub>4</sub> NO <sub>3</sub> .	Aq. 5% NH <sub>4</sub> Cl.	Mixture of 1 Pt. NH <sub>3</sub> (d = 0.96) + 4 Pts. H <sub>2</sub> O.	Aq. 5% NH <sub>4</sub> Cl + 4 NH <sub>3</sub> per 100.	Aq. 10% NH <sub>4</sub> Cl + 4 NH <sub>3</sub> per 100.
0	0.023	0.110	0.060	0.0087	...	...
20	0.052	0.046	0.105	0.0098	0.0165	0.0541
30	...	0.054	0.113	...	...	...
40	0.036	0.064	0.071	0.0136	...	...
50	0.030	0.072	0.093	0.0153	...	...
60	0.040	0.085	0.173	0.0174	0.0274	0.0731
70	0.016	0.083	0.124	0.0178	...	...
80	0.019	0.101	0.191	0.0145	...	...



## AMMONIUM PHOSPHATES 62

### AMMONIUM Manganese PHOSPHATE $\text{NH}_4\text{MnPO}_4 \cdot 7\text{H}_2\text{O}$ .

#### SOLUBILITY IN SEVERAL SOLVENTS.

(Wenger, 1911.)

t°.	Gms. $\text{NH}_4\text{MnPO}_4$ per 100 Gms. Solvent in:			
	Water.	Aq. 5% $\text{NH}_4\text{NO}_3$ .	Aq. 5% $\text{NH}_4\text{Cl}$ .	Mixture of 1 Pt. $\text{NH}_3$ ( $d=0.96$ ) + 4 parts $\text{H}_2\text{O}$ .
0	...	0.021	0.002	0.0116
20	0	0.020	0.025	0.0122
30	...	0.023	0.034	...
40	0	0.021	0.039	0.0118
50	...	0.023	0.035	0.0132
60	0	0.027	0.038	0.0194
70	0.005	0.028	0.041	0.0191
80	0.007	0.033	0.045	0.0197

### AMMONIUM Sodium PHOSPHATES

Data for the distribution of each of 5 ammonium sodium ortho- and pyro phosphates between water and chloroform at 18°, are given by Abbott and Bra (1909).

### AMMONIUM Hydrogen PHOSPHITE $(\text{NH}_4\text{H})\text{HPO}_3$ .

100 grams water dissolve 171 grams  $(\text{NH}_4\text{H})\text{HPO}_3$  at 0°, 190 grams at 14.1° and 260 grams at 31°. (Amat., 1887)

### AMMONIUM Hypo PHOSPHITE $\text{NH}_4\text{H}_2\text{PO}_3$ .

100 cc.  $\text{H}_2\text{O}$  dissolve 83 gms.  $\text{NH}_4\text{H}_2\text{PO}_3$  at room temp. (Squire and Caines, 1905)

### AMMONIUM PERMANGANATE $\text{NH}_4\text{MnO}_4$ .

100 parts water dissolve approximately 8 parts of  $\text{NH}_4\text{MnO}_4$  at 15°. (Aschoff

### AMMONIUM PICRATE $\text{C}_6\text{H}_2(\text{NO}_2)_3\text{ONH}_4$ .

100 cc.  $\text{H}_2\text{O}$  dissolve 1.1 gm. Am. picrate at room temp. (Squire and Caines, 1905)

100 cc. 90% alcohol dissolve 1.2 gm. Am. picrate at room temp.

(Squire and Caines, 1905)

### AMMONIUM Fluo SILICATE $(\text{NH}_4)_2\text{SiF}_6$ .

100 parts water dissolve 18.5 parts  $(\text{NH}_4)_2\text{SiF}_6$  at 17.5° Sp. Gr. 1.096.

(Stolba, 1877)

### AMMONIUM SALICYLATE $\text{C}_6\text{H}_4\text{OH.COONH}_4$ .

#### SOLUBILITY IN AQUEOUS ALCOHOL SOLUTIONS AT 25°.

(Seidell, 1909, 1910.)

Gms. $\text{C}_6\text{H}_4\text{OH}$ per 100 Gms. Solvent.	Sp. Gr. of Sat. Sol.	Gms. $\text{C}_6\text{H}_4\text{OHCOONH}_4$ per 100 Gms. Sat. Sol.	Gms. $\text{C}_6\text{H}_4\text{OH}$ per 100 Gms. Sat. Sol.	Sp. Gr. of Sat. Sol.	Gms. $\text{C}_6\text{H}_4\text{OHCOONH}_4$ per 100 Gms. Sat. Sol.
0	1.148	50.8	70	1.015	42
20	1.122	50.3	80	0.979	38
40	1.088	48.3	90	0.936	31.6
50	1.067	46.7	95	0.907	27.8
60	1.042	44.7	100	0.875	22.3

### AMMONIUM SELENATE $(\text{NH}_4)_2\text{SeO}_4$

100 gms.  $\text{H}_2\text{O}$  dissolve 1.22 gms.  $(\text{NH}_4)_2\text{SeO}_4$  at 12°.

(Tutton, 1901)



**AMMONIUM STEARATE**  $C_{18}H_{35}O_2NH_4$ .**SOLUBILITY IN SEVERAL SOLVENTS.**

(Falcia, 1910.)

°.	Gms. $C_{18}H_{35}O_2NH_4$ per 100 cc. of:				
	Absolute Alcohol.	75% Alcohol.	50% Alcohol.	Ether.	Acetone.
0	0.1	...	...	...	...
10	0.3	0.56	0.25	...	0.08 (13°)
20	0.5	...	0.51	0.1	...
30	0.9	1.83	1.16	...	...
40	1.8	5	3.21	...	...
50	5.5	...	...	...	...

**AMMONIUM SULFATE**  $(NH_4)_2SO_4$ .**SOLUBILITY IN WATER.**

(Mulder.)

°.	Grams $(NH_4)_2SO_4$ per 100 Grams.		°.	Grams $(NH_4)_2SO_4$ per 100 Grams.	
	Water.	Solution.		Water.	Solution.
0	70.6	41.4	30	78.0	43.8
5	71.8	41.8	40	81.0	44.8
10	73.0	42.2	60	88.0	46.8
15	74.2	42.6	80	95.3	48.8
20	75.4	43.0	100	103.3	50.8
25	76.7	43.4	108.9	107.5	51.8

Sp. Gr. of saturated solution at 15° = 1.248; at 19° = 1.241

Eutectic point, Ice +  $(NH_4)_2SO_4$  = -19.05° and 38.4 gms.  $(NH_4)_2SO_4$  per 100 gms. sat. solution.**SOLUBILITY IN AQUEOUS AMMONIA SOLUTIONS AT 25°.**

(D'Ans and Schreiner, 1910.)

Mols. per 1000 Gms. Sat. Sol.		Gms. per 1000 Gms. Sat. Sol.	
$(NH_3)$ .	$(NH_4)_2SO_4$ .	$(NH_3)$ .	$(NH_4)_2SO_4$ .
0	3.28	0	433.4
1.02	2.60	17.4	343.6
1.95	2.13	33.2	281.5
3.44	1.59	58.6	210.1
5.35	1.16	91.1	153.3
7.13	0.78	121.4	103
9.47	0	161.2	0

**SOLUBILITY OF AMMONIUM SULFATE IN AQUEOUS SOLUTIONS OF COPPER SULFATE AT 30° AND VICE VERSA.**

(Schreinemakers, 1910.)

Gms. per 100 Gms. Sat. Solution.		Solid Phase.	Gms. per 100 Gms. Sat. Solution.		Solid Phase.
$NH_4_2SO_4$ .	$CuSO_4$ .		$(NH_4)_2SO_4$ .	$CuSO_4$ .	
44	0	$(NH_4)_2SO_4$	8.19	13.65	1.1.6
38.32	0.77	$(NH_4)_2SO_4 + 1.1.6$	6.98	16.77	"
29.27	1.57	1.1.6	5.79	20.53	1.1.6 + $CuSO_4 \cdot 5H_2O$
17.53	4.05	"	2.45	20.19	$CuSO_4 \cdot 5H_2O$
9.33	11.03	"	0	20.32	"

\* = Solubility of 1.1.6 in water.

1.1.6 =  $CuSO_4(NH_4)_2SO_4 \cdot 6H_2O$ .

Several additional determinations for the above system at 19°, are given by Rüdorff (1873), and by Schiff (1859).



SOLUBILITY OF AMMONIUM SULFATE IN AQUEOUS SOLUTIONS OF FERROUS  
SULFATE AT 30° AND VICE VERSA.  
(Schreinemakers, 1910 a.)

Gms. per 100 Gms. Sat. Solution.		Solid Phase.	Gms. per 100 Gms. Sat. Solution.		Solid Phase.
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	FeSO <sub>4</sub> .		(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	FeSO <sub>4</sub> .	
44.27	0	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	8.90	17.64	1.1.6
43.88	0.79	(NH <sub>4</sub> )SO + 1.1.6	6.44	23.59	"
34.24	1.72	1.1.6	5.91	25.24	1.1.6 + FeSO <sub>4</sub> .7H
19.64	5.70	"	5.24	25.24	FeSO <sub>4</sub> .7H <sub>2</sub> O
16.29	7.95	"	0	24.90	"
11.45	13.13	"			

1.1.6 = (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>.FeSO<sub>4</sub>.6H<sub>2</sub>O.

Data for the quaternary system (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> + FeSO<sub>4</sub> + Li<sub>2</sub>SO<sub>4</sub> + H<sub>2</sub>O at are also given.

SOLUBILITY OF AMMONIUM SULFATE IN AQUEOUS SOLUTIONS OF LITHIUM  
SULFATE AND VICE VERSA.

(Schreinemakers, Cocheret, Filippo and deWaal, 1905, 1907.)

Results at 30°.			Results at 50°.		
Gms. per 100 Gms. Sat. Solution.		Solid Phase.	Gms. per 100 Gms. Sat. Solution.		Solid Phase.
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	Li <sub>2</sub> SO <sub>4</sub> .		(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	Li <sub>2</sub> SO <sub>4</sub> .	
44.1	0	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	45.7	0	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>
40.8	3		43.05	5.86	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> + NH <sub>4</sub> Li
39.5	6.6	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> + NH <sub>4</sub> LiSO <sub>4</sub>	19.65	16.35	NH <sub>4</sub> LiSO <sub>4</sub>
30	10	NH <sub>4</sub> LiSO <sub>4</sub>	13.90	21.20	"
21.6	15	"	13.97	21.23	NH <sub>4</sub> LiSO <sub>4</sub> + Li <sub>2</sub> SO <sub>4</sub> .1
15	20	"	11.45	21.75	Li <sub>2</sub> SO <sub>4</sub> .H <sub>2</sub> O
12.5	21.9	NH <sub>4</sub> LiSO <sub>4</sub> + Li <sub>2</sub> SO <sub>4</sub> .H <sub>2</sub> O	9.63	22.79	"
8.9	23	Li <sub>2</sub> SO <sub>4</sub> .H <sub>2</sub> O	8.58	23.09	"
0	25.1	"	7.56	22.86	"
			0	24.3	"

Additional data for the triple points of the above system at 20°, 57° and are given by Spielrein (1913), but the terms in which the results are present are not clearly shown.

Data for the quaternary system, ammonium sulfate, lithium sulfate, alkali and water at 6.5°, 30° and 50° are given by Schreinemakers and van Dorp (1910). A mixture of an excess of ammonium and of potassium sulfates in water 19° was found by Rüdorff (1873) to contain 37.97 gms. (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> + 39.3 g K<sub>2</sub>SO<sub>4</sub> per 100 gms. sat. solution.

SOLUBILITY OF AMMONIUM SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC  
ACID AT 30°.

(Van Dorp, 1910 and 1911.)

Gms. per 100 Gms. Sat. Solution.		Solid Phase.	Gms. per 100 Gms. Sat. Solution.		Solid Phase.
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	H <sub>2</sub> SO <sub>4</sub> .		(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	H <sub>2</sub> SO <sub>4</sub> .	
44.3	0	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	32.8	40	(NH <sub>4</sub> )HS
43.6	10	"	26.1	45	"
44.1	13.2	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> + 3.1	20.9	50	"
42.9	15	3.1	17.6	55	"
41	20	"	17.8	60	"
40.8	25	"	20	61.7	"
43	30	"	30	62.9	"
45.5	33.8	3.1 + (NH <sub>4</sub> )HSO <sub>4</sub>	37	62.2	"
42.3	35	(NH <sub>4</sub> )HSO <sub>4</sub>			

3.1 = 3[(NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>].H<sub>2</sub>SO.



Data for the solubility of ammonium sulfate in aqueous solutions of sulfuric acid of concentration extending to 10 gm. mols. per liter, are given by D'Ans (1909 and 1913).

Data for the solubility of ammonium and lithium sulfates in concentrated sulfuric acid containing traces of water, at 30°, are given by Van Dorp (1913-14).

**SOLUBILITY OF AMMONIUM SULFATE IN AQUEOUS SOLUTION OF ETHYL ALCOHOL AT 30° AND AT 50°.**

(Results at 30°, Wibaut, 1909; at 50°, Schreinemakers and de Baat, 1907.)

Results at 30°. Two liquid layers are formed at concentrations of alcohol between 5.8 and 62%. These have the compositions:

Upper Layer.			Lower Layer.		
Gms. per 100 Gms. Sat. Solution.			Gms. per 100 Gms. Sat. Solution.		
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.
2.2	56.6	41.2	37.1	5.8	57.1
2.6	54.5	42.9	35.7	6.3	58
3.4	52.3	44.3	33.8	7.4	58.8
13.2	31.8	55	21.7	18.4	50.9
17	25	58	17	25	58

At a concentration of 62% alcohol the liquid is homogeneous and contains 1.3 gms. (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> per 100 gms. sat. solution. At 90.4% alcohol no (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> is dissolved.

Results at 50°.

Gms. per 100 Gms. Saturated Solution.		
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.
43.02	2.32	54.66
41.1	4.1	54.8
1.2	64.5	34.3
0.2	75.5	24.3

Between the concentrations 4.1 and 64.5% C<sub>2</sub>H<sub>5</sub>OH the mixtures separate into two layers. The percentage composition of each member of several such conjoined layers, is as follows:

Upper Layer.			Lower Layer.		
Gms. per 100 Gms. Sat. Solution.			Gms. per 100 Gms. Sat. Solution.		
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.
1.2	64.5	34.3	41.1	4.1	54.8
1.6	60	38.4	36.8	6	57.2
3.8	50	46.2	30.8	9	60.2
7.4	40	52.6	26.6	12	61.4
10	34.4	55.6	23.6	15	61.4

Two determinations at 0° by deWaal (1910) gave 30 gms. (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> per 100 gms. sat. solution in 9.41% alcohol and 0.14 gm. (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> in 73.03% alcohol. Between these concentrations of alcohol two liquid layers are formed.

100 gms. 95% formic acid dissolve 25.4 gms. (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> at 16.5°.

(Aschan, 1913.)



SOLUBILITY OF AMMONIUM SULFATE IN AQUEOUS ETHYL ALCOHOL SOLUTIONS.  
 (Continued.)

(Traube and Neuberg — *Z. physik. Chem.* 1, 510, '87; Bodländer — *Ibid.* 7, 318, '91; Schreinemakers — *Ibid.* 23, 657, '97; de Bruyn — *Ibid.* 32, 68, '00; Linebarger — *Am. Ch. J.* 14, 380, '92.)

Upper Layer Results.		Gms. $C_2H_5OH$ per 100 Gms. Solution.	Lower Layer Results.		
Grams per 100 Gms. Solution at 10°-40°.			Gms. $(NH_4)_2SO_4$ per 100 g. Solution at:		
$C_2H_5OH$ .	$(NH_4)_2SO_4$ .		6.5°.	15°.	33°.
100	0.0	0	42.0	42.6	44
80	0.1	2.5	39.0	40.2	?
70	0.3	5.0	36.2	37.2	?
60	1.4	7.5	33.2	34.5	42
50	3.2	10.0	30.0	31.0	35
45	4.8	12.5	27.2	28.0	?
40	6.6	15.0	24.6	25.2	?
35	9.2	17.5	22.0	22.4	?
30	12.2	20.0	20.0	20.0	?
25	14.6				

NOTE. — When ammonium sulfate is added to aqueous solutions of alcohol, it is found that for certain concentrations and temperatures the solutions separate into two liquid layers, the upper of which contains the larger percentage of alcohol.

Most of the determinations which have been made upon this system, as contained in the papers referred to above, are given in terms of grams of ammonium sulfate, of alcohol and of water per 100 grams of these three components taken together. Those results which are given in other terms can be readily calculated to this basis, and it is, therefore, possible to make a comparison of the several sets of determinations by plotting on cross-section paper and drawing curves through the points. In the present case the grams of alcohol per 100 grams of solution were taken as ordinates, and the grams of ammonium sulfate in the same quantity of each solution taken as abscissæ. It was found that a single curve could be drawn through practically all the points representing the upper layer solutions at the several temperatures, but the points for the solutions containing the larger amounts of water gave curves which diverged with increase of temperature. The results given for 33° in the above table are not to be accepted as correct until further work has been done.

 SOLUBILITY OF AMMONIUM SULFATE IN AQUEOUS PROPYL ALCOHOL SOLUTIONS  
 AT 20°.

(Linebarger — *Am. Ch. J.* 14, 380, '92.)

Gms. per 100 Gms. Solution.		Gms. per 100 Gms. Solution.	
$C_3H_7OH$ .	$(NH_4)_2SO_4$ .	$C_3H_7OH$ .	$(NH_4)_2SO_4$ .
70	0.4	40	3.2
60	1.0	30	4.8
50	2.0	20	6.7



## 67 AMMONIUM Cadmium SULFATE

### AMMONIUM Cadmium SULFATE $(\text{NH}_4)_2\text{Cd}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ .

100 cc.  $\text{H}_2\text{O}$  dissolve 72.3 gms.  $(\text{NH}_4)_2\text{Cd}(\text{SO}_4)_2$  at  $25^\circ$ . (Locke, 1901.)

### AMMONIUM Chromium SULFATE (Alum) $(\text{NH}_4)_2\text{Cr}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$ .

100 cc.  $\text{H}_2\text{O}$  dissolve 10.78 gms. anhydrous or 21.21 gms. hydrated salt at  $25^\circ$ . (Locke, 1901.)

### AMMONIUM Cobalt SULFATE $(\text{NH}_4)_2\text{Co}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ .

#### SOLUBILITY IN WATER.

(Tobler — Liebigs Annalen 95, 193, '55; v. Hauer — J. pr. Chem. 74, 433, '58; at  $25^\circ$ , Locke — Am. Ch. J. 27, 459, '01.)

$t^\circ$ .	Gms. $(\text{NH}_4)_2\text{Co}(\text{SO}_4)_2$ per 100 Gms.		$t^\circ$ .	Gms. $(\text{NH}_4)_2\text{Co}(\text{SO}_4)_2$ per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	6.0	5.7	40	22.0	18.0
10	9.5	8.7	50	27.0	21.3
20	13.0	11.5	60	33.5	25.1
25	14.72	12.8	70	40.0	28.6
30	17.0	14.5	80	49.0	32.9

NOTE. — The determinations reported by the above named investigators were plotted on cross-section paper and although considerable variations were noted, an average curve which probably represents very nearly the true conditions was drawn through them, and the above table made from this curve.

### AMMONIUM Indium SULFATE $(\text{NH}_4)_3\text{In}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 200 gms. salt at  $16^\circ$  and 400 gms. at  $30^\circ$ . (Rösler, 1873.)

### AMMONIUM Iron SULFATE (Alum) $(\text{NH}_4)_2\text{Fe}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$ .

100 cc.  $\text{H}_2\text{O}$  dissolve 44.15 gms. anhydrous or 124.40 gms. hydrated salt at  $25^\circ$ . Sp. gr. of saturated solution at  $15^\circ = 1.203$ . (Locke, 1901.)

### AMMONIUM Iron SULFATE (ferrous) $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ .

#### SOLUBILITY IN WATER.

(Tobler; at  $25^\circ$ , Locke — Am. Ch. J. 2KK, 459, '01.)

$t^\circ$ .	G. $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$ per 100 g. $\text{H}_2\text{O}$ .	$t^\circ$ .	G. $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$ per 100 g. $\text{H}_2\text{O}$ .	$t^\circ$ .	G. $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$ per 100 g. $\text{H}_2\text{O}$ .
0	12.5	25	25.0 (T)	50	40
15	20.0	25	35.1 (L)	70	52
		40	33.0		

### AMMONIUM Lead SULFATE $(\text{NH}_4)_2\text{SO}_4 \cdot \text{PbSO}_4$ .

#### SOLUBILITY IN WATER.

(Barre, 1909.)

$t^\circ$ .	Gms. $(\text{NH}_4)_2\text{SO}_4$ per 100 Gms.		Solid Phase.
	Sat. Solution.	Water.	
20	12.17	13.86	$(\text{NH}_4)_2\text{SO}_4 \cdot \text{PbSO}_4$
50	16.15	19.25	"
75	19.52	24.31	"
100	22.74	29.42	"



**AMMONIUM Lithium SULFATE 68****AMMONIUM Lithium SULFATE**  $\text{NH}_4\text{LiSO}_4$ .

## SOLUBILITY IN WATER.

(Schreinemakers, Cocheret, Filippo and deWaal, 1905, 1907.)

t°.	Gms. $\text{NH}_4\text{LiSO}_4$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{NH}_4\text{LiSO}_4$ per 100 Gms. Sat. Sol.	Solid Phase
0	0	Ice	-10	35.25	$\text{NH}_4\text{LiSO}_4$
-5	14	"	+10	35.58	"
-10	23.5	"	30	25.87	"
-15	29.7	"	50	36	"
-20.6 Eutec.	35.15	Ice + $\text{NH}_4\text{LiSO}_4$	70	36.18	"

**AMMONIUM Magnesium SULFATE**  $(\text{NH}_4)_2\text{Mg}(\text{SO}_4)_2$ .

## SOLUBILITY OF AMMONIUM MAGNESIUM SULFATE IN WATER.

(Porlezza, 1914.)

t°.	Gms. per 100 Gms.		Solid Phase.	t°.	Gms. per 100 Gms.		Solid Phase
	Sat. Sol.	Water.			Sat. Sol.	Water.	
-0.34	1.01	1.02	Ice	20	15.23	17.96	$(\text{NH}_4)_2\text{Mg}(\text{SO}_4)_2$
-0.80	2.98	3.07	"	25	16.45	19.69	"
-1.23	4.92	5.17	"	30	17.84	21.71	"
-1.60	6.56	7.02	"	40	20.51	25.86	"
-2.02	8.34	9.10	"	50	23.18	30.17	"
-2.34 Eutec.	...	...	Ice + $(\text{NH}_4)_2\text{Mg}(\text{SO}_4)_2$	60	26.02	35.17	"
0	10.58	11.83	$(\text{NH}_4)_2\text{MgSO}_4$	80	32.58	48.32	"
10	12.75	14.61	"	100	39.66	65.72	"

**AMMONIUM Manganese SULFATE**  $(\text{NH}_4)_2\text{Mn}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ .100 cc. water dissolve 37.2 gms.  $(\text{NH}_4)_2\text{Mn}(\text{SO}_4)_2$  at 25°.

(Locke, 1901)

**AMMONIUM Nickel SULFATE**  $(\text{NH}_4)_2\text{Ni}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Average curve from Tobler, Locke, at 25°.)

t°.	G. $(\text{NH}_4)_2\text{Ni}(\text{SO}_4)_2$ per 100 Gms.		t°.	G. $(\text{NH}_4)_2\text{Ni}(\text{SO}_4)_2$ per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	1.0	0.99	40	12.0	10.72
10	4.0	3.85	50	14.5	12.96
20	6.5	6.10	60	17.0	14.53
25	7.57	7.04	70	20.0	16.66
30	9.0	8.45			

**AMMONIUM Sodium SULFATE**  $\text{NH}_4\text{NaSO}_4 \cdot 2\text{H}_2\text{O}$ .100 gms. water dissolve 46.6 gms.  $\text{NH}_4\text{NaSO}_4 \cdot 2\text{H}_2\text{O}$  at 15° Sp. Gr., of Sol. 1.1749.**AMMONIUM Strontium SULFATE**  $(\text{NH}_4)_2\text{SO}_4 \cdot \text{SrSO}_4$ .

## SOLUBILITY IN WATER.

(Barre, 1909.)

t°.	Gms. $(\text{NH}_4)_2\text{SO}_4$ per 100 Gms.		Solid Phase.
	Sat. Solution.	Water.	
50	43.99	78.54	$(\text{NH}_4)_2\text{SO}_4 \cdot \text{SrSO}_4 + \text{SrSO}_4$
75	45.40	83.15	"
100	46.27	66.2	"



## 69 AMMONIUM Vanadium SULFATE

**AMMONIUM Vanadium SULFATE** (Alum)  $(\text{NH}_4)_2\text{V}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$ .

100 cc.  $\text{H}_2\text{O}$  dissolve 31.69 gms. anhydrous or 78.50 gms. hydrated salt at  $25^\circ$ .  
(Locke.)

**AMMONIUM Zinc SULFATE**  $(\text{NH}_4)_2\text{Zn}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ .

### SOLUBILITY IN WATER.

(Average curve, see Notz, p. 67, Tobler, Locke, at  $25^\circ$ .)

$t^\circ$ .	G. $(\text{NH}_4)_2\text{Zn}(\text{SO}_4)_2$ per 100 Gms.		$t^\circ$ .	G. $(\text{NH}_4)_2\text{Zn}(\text{SO}_4)_2$ per 100 Gms.	
	Solution.	Water.		Solution.	Water.
0	6.54	7.0	40	16.66	20
10	8.67	9.5	50	20.0	25
20	11.11	12.5	60	23.1	30
25	12.36	14.1	70	25.9	35
30	13.79	16.0	80	29.6	42

**AMMONIUM PERSULFATE**  $(\text{NH}_4)_2\text{S}_2\text{O}_8$ .

100 parts  $\text{H}_2\text{O}$  dissolve 58.2 parts  $(\text{NH}_4)_2\text{S}_2\text{O}_8$  at  $0^\circ$ . (Marshall, 1891.)

**AMMONIUM Sodium Hydrogen SULFITE**  $(\text{NH}_4)\text{Na}_2\text{H}(\text{SO}_3)_4 \cdot \text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 42.3 gms. salt at  $12.4^\circ$  and 48.5 gms. at  $15^\circ$ .  
(Schwincker, 1889.)

**AMMONIUM Antimony SULFIDE** (Sulfoantimonate)  $(\text{NH}_4)_3\text{SbS}_4 \cdot 4\text{H}_2\text{O}$ .

### SOLUBILITY IN WATER AND IN AQUEOUS ALCOHOL.

(Donk, 1908.)

In Water.			In Aqueous Alcohol at $10^\circ$ .		
$t^\circ$ .	Gms. $(\text{NH}_4)_3\text{SbS}_4$ per 100 Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Solution.	$\text{C}_2\text{H}_5\text{OH}$ .	$(\text{NH}_4)_3\text{SbS}_4$ .
-1.9	9.9	Ice	0	43.2	
-5	20		5.1	35.9	
-8	30.2		19.1	23.1	
-13.5	41.6	Ice + $(\text{NH}_4)_3\text{SbS}_4 \cdot 4\text{H}_2\text{O}$	43.1	8.7	
0	41.6		53.1	4.1	
+20	47.7	"	93.3	0	
30	54.5				

**AMMONIUM  $\beta$ -Naphthalene Mono SULFONATE**  $\text{C}_{10}\text{H}_7\text{SO}_3\text{NH}_4$ .

100 cc. of the saturated aqueous solution contain 13.05 gms. of the salt at  $25^\circ$ , and  $d_{25} = 1.034$ . (Witt, 1915.)

**AMMONIUM Phenanthrene Mono SULFONATES**  $\text{C}_{14}\text{H}_9\text{SO}_3\text{NH}_4$  (2), (3) and (10).

### SOLUBILITY IN WATER AT $20^\circ$ .

(Sandquist, 1912.)

100 gms.  $\text{H}_2\text{O}$  dissolve 0.37 gms.  $\text{C}_{14}\text{H}_9\text{SO}_3\text{NH}_4$  (2).

100 gms.  $\text{H}_2\text{O}$  dissolve 0.26 gms.  $\text{C}_{14}\text{H}_9\text{SO}_3\text{NH}_4$  (3).

100 gms.  $\text{H}_2\text{O}$  dissolve 4.41 gms.  $\text{C}_{14}\text{H}_9\text{SO}_3\text{NH}_4$  (10).

**AMMONIUM 2,5 di-iodobenzene SULFONATE**  $\text{C}_6\text{H}_3\text{I}_2\text{SO}_3(\text{NH}_4)$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 4.35 gms. salt at  $20^\circ$ . (Boyle, 1909.)

**AMMONIUM TARTRATES**  $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$ .

100 cc.  $\text{H}_2\text{O}$  dissolve 2.83 gms.  $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6 \cdot 2\text{H}_2\text{O}$  at  $0^\circ$ . (Fenton, 1898.)

100 cc.  $\text{H}_2\text{O}$  dissolve 5.9 gms.  $(\text{NH}_4)_2\text{C}_4\text{H}_4\text{O}_6$  at  $15^\circ$  ( $d = 1.04$ ).

(Greenish and Smith, 1903.)

**AMMONIUM Lithium TARTRATES** dextro and racemic.

100 gms. sat. sol. in  $\text{H}_2\text{O}$  contain 13.104 gms. racemate  $(\text{NH}_4)\text{Li}(\text{C}_4\text{H}_4\text{O}_6) \cdot \text{H}_2\text{O}$  at  $20^\circ$ .

100 gms. sat. solution in  $\text{H}_2\text{O}$  contain 14.186 gms. dextro  $(\text{NH}_4)\text{Li}(\text{C}_4\text{H}_4\text{O}_6)$ .

$\frac{1}{2}$   $\text{H}_2\text{O}$  at  $20^\circ$ .

(Schlossberg, 1900.)

Freezing-point data for mixtures of water and ammonium tartrate and of water and ammonium racemate are given by Bruni and Finzi (1905).



## AMMONIUM THIOCYANATE 70

### AMMONIUM THIOCYANATE $\text{NH}_4\text{SCN}$

#### SOLUBILITY IN WATER.

(Average curve from results of Rüdorff, 1868 and 1872; Wasallijew, 1910; Smits and Kettner,

t°.	Gms. $\text{NH}_4\text{SCN}$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{NH}_4\text{SCN}$ per 100 Gms. Sat. Sol.	Sol Phs
-10	20	Ice	0	54.5	$\text{NH}_4\text{SCN}$
-15	28.5	"	+10	59	"
-20	35.5	"	20	63	"
-25.2	42 Eutec.	Ice + $\text{NH}_4\text{SCN}$	25	65.5	"
-10	50	$\text{NH}_4\text{SCN}$	30	67.5	"

Data for the system ammonium thiocyanate, thiourea and water at 2 given by Smits and Kettner (1912) in the form of a triangular diagram, the numerical results are omitted. The diagram confirms the freezing-point results in showing that the molecular compound  $\text{NH}_4\text{SCN} \cdot 4(\text{NH}_4)_2\text{CS}$  is formed.

100 gms. acetonitrile dissolve 7.52 gms.  $\text{NH}_4\text{SCN}$  at 18°. (Naumann and Schie

Freezing-point curves have been determined for the following mixtures:

Ammonium Thiocyanate + Ammonia.	(Bradley and Alexander)
" " + Potassium Thiocyanate.	(Wrzesnewak)
" " + Thiocarbamide (Thiourea).	(Renolds and Werner)
Findlay, 1904; Atkins and Werner, 1912; Smits and Kettner, 1912; Wrzesnewak;	

### AMMONIUM URATE (Primary) $\text{C}_5\text{H}_5\text{N}_4\text{O}_3\text{NH}_4$

#### SOLUBILITY OF THE LACTAM AND LACTIM FORMS IN WATER.

(Gudzeit, 1908-09.)

t°.	Gms. of Each per 1000 cc. Sat. Solution.		
	Lactam.	Lactim.	Mixture of the Two.
18	0.456	0.304	0.414
37	0.817	0.540	0.741

### AMMONIUM Meta VANADATE $\text{NH}_4\text{VO}_3$

#### SOLUBILITY IN WATER AND IN AQUEOUS AMMONIUM SALT AND AMMONIUM HYDROXIDE SOLUTIONS.

(Meyer, 1909.)

Gms. per 1000 cc. in Each Solvent.

t°.	Water.	0.05 n. $\text{NH}_4\text{Cl}$	0.1 n. $\text{NH}_4\text{Cl}$	0.05 n. $\text{NH}_4\text{NO}_3$	0.1 n. $\text{NH}_4\text{NO}_3$	0.0668 n. $\text{NH}_3$	0.245 n. $\text{NH}_3$
18	4.35	1.66	0.41	1.67	0.58	5.58	7.97
25	6.08	2.63	1.17	2.77	1.23	7.06	8.58
35	10.77	5.21	2.69	...	...	...	...
45	15.71	8.88	5.40	...	...	...	...
55	19.97	11.18	7.40	...	...	...	...
70	30.47	...	...	...	...	...	...

100 cc. anhydrous hydrazine dissolve 2 gms. ammonium metavanadate at room temp. (Welsh and Broderick)

### AMYGDALIN $\text{C}_{20}\text{H}_{27}\text{NO}_3 \cdot 3\text{H}_2\text{O}$

100 gms. trichlorethylene dissolve 0.029 gm. amygdalin at 15°.

(Wester and Bruin)

### AMYL ACETATE BUTYRATE, FORMATE, etc.

#### SOLUBILITY IN WATER AND IN AQUEOUS ALCOHOL AT 20°

(Bancroft—Phys. Rev. 3, 131, 196, 205, '95-'96; Traube.—Ber. 17, 2304, '84.)

Ester.	cc. Ester per 100 cc. $\text{H}_2\text{O}$ .	Sp. Gr. of Ester.	Ester.	cc. Ester per 100 cc. $\text{H}_2\text{O}$ .
Amyl acetate	0.2	0.88	Amyl propionate	0.1
Iso amyl acetate	0.2 (1.2?)	...	Iso amyl formate	0.3 (gms. 1)
Amyl butyrate	0.06	0.85		



## SOLUBILITY IN AQUEOUS ALCOHOL AT ROOM TEMPERATURE.

(Pfeiffer, 1892.)

Solubility of Iso Amyl Acetate in Aq. Alcohol Mixtures. Solubility of Amyl Acetate and Amyl Formate in Aq. Alcohol Mixtures.

Per 5 cc. $C_5H_{11}OH$ .		cc. $C_5H_{11}OH$ in Mixture.	cc. $H_2O$ added to cause separation of second phase in mixtures of the given amounts of alcohol and 3 cc. portions of:	
cc. $H_2O$ .	cc. Iso Amyl acetate.		Amyl Formate.	Amyl Acetate.
7	0.41	3	1.80	1.76
6	0.7	9	8.77	9.03
5	1.31	15	17.01	17.52
3.61	3.0	21	27.06	26.99
3.01	4.0	27	38.31	37.23
2.60	5.0	33	50.71	48.41
		39	65.21	...
		45	85.10	...
		48	94.20	...

AMYL ALCOHOL  $C_5H_{11}OH$ .

## SOLUBILITY OF AMYL ALCOHOL IN WATER AT 22°.

(Herz — Ber. 31, 2671, '98.)

100 cc. water dissolve 3.284 cc. amyl alcohol. Sp. Gr. of solution = 0.9949, Volume = 102.99 cc.

100 cc. amyl alcohol dissolve 2.214 cc. water. Sp. Gr. of solution = 0.8248, Volume = 101.28 cc.

Sp. Gr. of  $H_2O$  at 22° = 0.9980; Sp. Gr. of amyl alcohol at 22° = 0.8133.

## SOLUBILITY IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL.

(Pfeiffer, 1892; Bancroft, 1895-96.)

Mixture of $C_5H_{11}OH + C_2H_5OH$		c.c. $H_2O$ added to ° Mixture at		Mixture of $C_5H_{11}OH + C_2H_5OH$		c.c. $H_2O$ Added to ° Mixture at	
cc.	cc.	9.1°.	19.2°.	cc.	cc.	13.3°.	17.4°.
3	3	3.21	3.5	3	3	3.36	3.47
3	6	10.35	10.80	6	3	2.20	2.25
3	9	18.34	19.10	9	3	2.10	2.15
3	12	27.47	29.15	12	3	2.10	2.10
3	15	41.25	43.15	15	3	2.10	2.10

\* Just enough water was added to produce cloudiness.

NOTE. — The effect of various amounts of a large number of salts upon the temperature (39.8°) at which a mixture of 20 cc. of amyl alcohol + 20 cc. of ethyl alcohol + 32.9 cc. of water becomes homogeneous has been investigated by Pfeiffer (Z. phys. Ch. 9, 444, '92). The results are no doubt of interest from a solubility standpoint, but their recalculation to terms suitable for presentation in the present compilation has not been attempted.

## DISTRIBUTION OF ISOAMYL ALCOHOL BETWEEN WATER AND COTTON SEED OIL AT 25°.

(Wroth and Reid, 1916.)

Gms. $C_5H_{11}OH$ per 100 c.c.		Ratio.
Oil Layer.	$H_2O$ Layer.	
1.947	0.9153	0.470
2.195	1.1156	0.508
2.273	1.1050	0.486
2.372	0.9995	0.421



## AMYL ALCOHOL

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### SOLUBILITY OF AMYL ALCOHOL IN WATER AND IN AQUEOUS SOLUTIONS OF ETHYL AND METHYL ALCOHOLS.

(Fontein, 1910.)

In Water.			In Aq. Ethyl Alcohol.*			In Aq. Methyl.		
t°.	Gms. C <sub>5</sub> H <sub>11</sub> OH per 100 Gms.		t°.	Gms. C <sub>5</sub> H <sub>11</sub> OH per 100 Gms.		t°.	Gms. C <sub>5</sub> H <sub>11</sub> OH per 100 Gms.	
	H <sub>2</sub> O Layer.	C <sub>5</sub> H <sub>11</sub> OH Layer.		C <sub>5</sub> H <sub>11</sub> OH + H <sub>2</sub> O Layer.	C <sub>5</sub> H <sub>11</sub> OH Layer.		CH <sub>3</sub> OH + H <sub>2</sub> O Layer.	C <sub>5</sub> H <sub>11</sub> OH Layer.
0.5	4	...	4.5	16.2	...	3.6	11	...
15.5	2.6	90.7	20	20.8	...	20	19.3	...
20	2.6	90.6	40	26.7	...	38.4	...	...
40	2.1	89.5	60	33	...	40	31.2	...
60	2	88	67.8	...	24.4	50	37.1	...
80	2.5	86	70	36.5	73.7	60	43.3	...
100	3	83.8	80	40.8	70.1	70	52.7	...
120	3.8	80.8	90	47	64	72	(crit. t.)	...
140	5	76.4	94.2	(crit. temp.)				
160	7.3	70						
170	9.3	65.1						
180	13.5	57.3						
187.5	(crit. temp.)							

\* Of 33.55 per cent C<sub>5</sub>H<sub>11</sub>OH.

† Of 33 per cent CH<sub>3</sub>OH.

The "synthetic method" was used for the preceding determination. Amyl alcohol of b. pt. 131°-131.4° and  $d_{4}^{20} = 0.814$  was used. It contained 16% of optically active amyl alcohol. Many other series of determinations were made with solvents containing other percentages of ethyl and methyl alcohol. Also, other series were made for the above-named systems at constant temperatures from which binodal curves were constructed. The author uses a very ingenious indirect method for determining the critical temperature of the conjugated solutions. Data are also given for the distribution of amyl alcohol between water and amyl alcohol.

The results of Alexejew (1886) for the solubility of amyl alcohol in water agree fairly well with the above data.

## AMYL AMINE C<sub>5</sub>H<sub>11</sub>.NH<sub>2</sub>.

The freezing-point curve for mixtures of amyl amine and water is given by Pickering (1893).

## Iso AMYLAMINE HYDROCHLORIDE C<sub>5</sub>H<sub>11</sub>.NH<sub>2</sub>.HCl (iso).

100 gms. H<sub>2</sub>O dissolve 192.2 gms. of the salt at 25°. (Peddle and Turner, 1903.)  
100 gms. CHCl<sub>3</sub> dissolve 5.1 gms. of the salt at 25°.

Data for the distribution of  $\epsilon$ -chloramyl amine between water and chloroethane at 0°, water and nitrobenzene at 25° and water and benzene at 40° are given by Freundlich and Richards (1912).

## AMYLENE (Trimethylethylene) (CH<sub>3</sub>)<sub>2</sub>C:CHCH<sub>3</sub>.

### RECIPROCAL SOLUBILITY IN ANILINE; DETERMINATIONS BY SYNTHETIC METHOD (Konowalow, 1903.)

t°.	Gms. Aniline per 100 Gms.		t°.	Gms. Aniline per 100 Gms.	
	Amylene Layer.	Aniline Layer.		Amylene Layer.	Aniline Layer.
0	19.5	81.5	10	28	72
2	19.7	80.5	12	34	66
4	20.5	79.5	13	38.5	61.5
6	21.7	78	14	45	55
8	24.2	75.8	14.5	(crit. temp.)	51.6



SOLUBILITY OF AMYLENE IN LIQUID CARBON DIOXIDE.  
(Büchner, 1905-06.)

(Determinations made by the synthetic method.)

t°. (crit.)	31	103	201
Gms. $C_4H_{10}$ per 100 gms. sat. sol.	0	38	100

AMYLENE HYDRATE  $(CH_3)_2C(OH)CH_2CH_3$ .

The distribution coefficient of amylene hydrate between olive oil and water at ord. temp. is 1. (Baum, 1899.)

ANDROMEDOTOXINE  $C_{21}H_{41}O_{10}$ .

SOLUBILITY IN SEVERAL SOLVENTS AT 12° AND AT THE BOILING-POINTS OF THE SOLVENTS.  
(Zaayer, 1886.)

Solvent.	Gms. $C_{21}H_{41}O_{10}$ per 100 Gms. Sat. Sol. at :	
	12°.	B. Pt.
Water	2.81	0.87
Ethyl alcohol ( $d_{12} = 0.821$ )	11.70	...
Amyl alcohol	1.14	...
Chloroform	0.26	0.26
Commercial ether	0.07	0.07
Benzine	0.004	...

ANETHOLE (*p* Propylanisole)  $CH_3CHCH[4]C_6H_4OCH_3$ .

SOLUBILITY IN AQUEOUS ALCOHOL AT 20°

(Schimmel and Co., Reports, Oct. 1895, p. 6.)

Vol. per cent alcohol =	20	25	30	40	50
Gm. anethole per liter aq. alcohol =	0.12	0.20	0.32	0.86	2.30
333 gms. anethole dissolve in one liter of 90% alcohol at room temperature. (Squire and Caines, 1905.)					

Freezing-point data for mixtures of anethole and menthol are given by Scheuer (1910).

ANILINE  $C_6H_5(NH_2)$ .

SOLUBILITY IN WATER AT 22°.

(Herz, 1898; see also Vaubel, 1895; Aignan and Dugas, 1899.)

100 cc.  $H_2O$  dissolve 3.481 cc.  $C_6H_5(NH_2)$  — Vol. of Sol. = 103.48, Sp. Gr. = 0.9986.

100 cc.  $C_6H_5(NH_2)$  dissolve 5.22 cc.  $H_2O$  — Vol. of Sol. = 104.96, Sp. Gr. = 1.0175.

100 cc. sat. aq. sol. contain 3.607 gms.  $C_6H_5NH_2$  at 25°. (Reidel, 1906.)

SOLUBILITY OF ANILINE IN WATER. (Determination by synthetic method.)  
(Sidgwick, Pickford and Wiladen, 1911.)

t°.	Gms. $C_6H_5NH_2$ per 100 Gms.		t°.	Gms. $C_6H_5NH_2$ per 100 Gms.	
	Aq. Layer.	Aniline Layer.		Aq. Layer.	Aniline Layer.
13.8	3.611	5.12 (20°)	120	9.1	14.6
30	3.7	5.4	130	11.2	16.9
50	4.2	6.4	140	13.5	19.5
70	5	7.7	150	17.1	24
90	6.4	9.9	160	22	32
110	8	13	165	26.1	...

The critical solution temperature for aniline and water is 168°.

Alexejew (1886) and Rothmund (1898) obtained results for the preceding system which differ in part quite widely from the above table.

More recent determinations, in terms of cc. aniline per 100 cc. of mixture, are given by Kolthoff (1917).



**SOLUBILITY OF ANILINE IN AQUEOUS SOLUTIONS OF ANILINE HYDROCHLORIDE.**  
(Sidgwick, Pickford and Wilsden, 1911.)

The temperatures at which a second liquid phase separated from homogeneous mixtures of known amounts of aniline + HCl + H<sub>2</sub>O were determined for a very extensive series of mixtures. The procedure consisted in first heating a given mixture until it became homogeneous and then cooling it slowly, with constant shaking. A critical turbidity preceding the actual separation by a few degrees was always noticed. The point of separation was taken as that at which a small gas flame seen through the liquid disappeared. At higher temperatures, the observations were made on mixtures contained in sealed bulbs. In the actual experiments, binodal curves for mixtures of Aq. HCl (of different strengths) and aniline were determined. By interpolation from these, the following isothermal curves were obtained.

## Isotherm for 15°.

H <sub>2</sub> O Rich Mixtures. Gms. per 100 Gms. Sat. Solution.		Aniline Rich Mixtures. Gms. per 100 Gms. Sat. Solution.	
C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> .	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> .HCl.	H <sub>2</sub> O.	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> .HCl.
3.615	0	7.276	3.025
3.791	1.529	7.231	1.989
4.144	5.829	5.816	1.195
4.940	11.44	5.230	0.340
5.995	16.03	5.006	0.163
10.44	19.35	4.960	0.080
26.80	21.49	4.942	0

## Isotherm for 25°.

H <sub>2</sub> O Rich Mixtures. Gms. per 100 Gms. Sat. Solution.		Aniline Rich Mixtures. Gms. per 100 Gms. Sat. Solution.	
C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> .	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> .HCl.	H <sub>2</sub> O.	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> .HCl.
3.681	0	14	8.884
4.020	3.02	10.84	6.062
5.380	11.40	6.949	1.912
7.023	15.83	6.043	0.828
11.86	19.02	5.568	0.363
31.35	20.15	5.311	0.089
59.95	15.55	5.299	0

## Isotherm for 40°.

3.941	0	15.65	8.752
4.187	1.523	10.21	4.243
4.371	3.009	7.874	2.166
4.823	5.815	7.069	1.452
6.210	11.30	7.058	0.9669
8.779	15.55	6.225	0.4052
38.69	18	5.940	0.0960
64.20	12.84	5.930	0

## Isotherm for 60°.

4.58	0	14.27	5.93
4.87	1.512	9.569	2.632
5.13	2.984	8.109	1.112
5.67	5.762	7.492	0.4876
7.69	11.14	7.051	0.2284
11.53	15.25	7.047	0.1138
22.80	16.66	7.030	0
51.10	14.36		

## Isotherm for 80°.

5.66	0	12.31	3.387
5.95	1.495	9.848	1.350
6.26	2.950	8.998	0.5857
7.11	5.678	8.524	0.2769
9.95	10.85	8.512	0.1387
31.18	14.85	8.500	0

## Isotherm for 100°.

7.10	0	41.57	11.45
7.68	1.467	18.16	4.995
8.10	2.891	12.76	1.784
9.60	5.522	11.37	0.1836
13.60	10.41	11.90	0

## Isotherm for 120°.

9.30	0	17.94	2.459
21.21	9.497	14.45	0

## Isotherm for 140°.

13.75	0	29.52	4.043
38.75	7.384	21.09	0

The authors also calculated the position of tie lines for the binodal curves with the aid of distribution coefficients, which they determined at 25° and which are quoted in a subsequent table (page 78 following).

Additional data for the system aniline + HCl + H<sub>2</sub>O at 0°, 25° and at 35° are given by Thonus (1913), and for aniline + HCl by Leopold (1910).



## SOLUBILITY OF ANILINE IN AQUEOUS SALT SOLUTIONS AT 18°.

(Euler — Z. physik. Chem. 49, 307, '04.)

Aq. Solution.	Gms. Salt per liter.	Gms. $C_6H_5(NH_2)$ per 100 g. solvent.	Aq. Solution.	Gms. Salt per liter.	Gms. $C_6H_5(NH_2)$ per 100 g. solvent.
$H_2O$ alone	0	3.61	1 $nNaOH$	40.06	1.90
0.5 $nKCl$	37.3	3.15	1 $nLiCl$	42.48	2.80
1 $nKCl$	74.6	2.68	1 $nCaCl_2$	67.25	3.00
1 $nNaCl$	58.5	2.55			

## SOLUBILITY OF ANILINE IN AQUEOUS ANILINE HYDROCHLORIDE SOLUTIONS AT 18°.

(Lidow — J. russ. phys. chem. Ges. 15, 420, '83; Ber. 16, 2297, '83.)

Per cent $C_6H_5NH_2HCl$ in Solvent.	Gms. $C_6H_5NH_2$ per 100 g. Solvent	Per cent $C_6H_5NH_2HCl$ in Solvent.	Gms. $C_6H_5NH_2$ per 100 g. Solvent.
5	3.8	30	39.2
12	5.3	35	50.4

SOLUBILITY OF ANILINE IN AQUEOUS SOLUTIONS OF GLYCEROL AND VICE VERSA.  
(Kolthoff, 1917.)

(The liquids were measured from burets. The determinations at 100° were made in sealed tubes. The others were made in open tubes.)

## Results for the Solubility of Aniline in Aqueous Glycerol.

Per cent Glycerol in Aq. Mixture used.	cc. Aniline dissolved by 100 cc. of Aq. Glycerol of Conc. shown at:			
	18°.	25°.	36°.	100°.
0 (= water)	3.25	3.4	5.6	9.9
39	5.15	5.3	...	...
56	7.5	7.6	...	28 (58% Glycerol)
65	10	...	...	38 (66% " )
74.3	11.75	12.1	...	...
78	20	20	16	...
87	70	...	...	...

## Results for the Solubility of Aqueous Glycerol in Aniline.

Per cent Glycerol in Aq. Mixture used.	cc. of Aq. Glycerol Mixture dissolved by 100 cc. Aniline at:			
	18°.	25°.	36°.	100°.
0 (= water)	4.6	5	4	5.3
39	...	6.4	...	...
47	5.2	...	...	...
56	7.9	7.7	...	15 (58% Glycerol)
74.3	13.1	11.7	...	17 (66% " )
78	17.1	14.8	...	...

## DISTRIBUTION OF ANILINE BETWEEN WATER AND BENZENE AT 25°.

(Farmer and Warth, 1904.)

Gms. $C_6H_5NH_2$ per 100 cc.		Ratio.
Water Layer.	$C_6H_6$ Layer.	
0.0135	0.1312	9.7
0.0122	0.1282	10.5
0.0065	0.0656	10.1

Data for the distribution between water and benzene at 25° of each of the following substituted anilines; *o*, *m* and *p* nitraniline, chloraniline, bromaniline, *p* nitrosomethylaniline, and *p* nitrosodimethylaniline are given by Farmer and Warth (1904).



## SOLUBILITY OF ANILINE, PHENOL MIXTURES IN WATER.

(Schreinemaker — Z. physik. Chem. 29, 584; 30, 460, '00.)

Mixture used = 25.4 Mols. Aniline + 74.6 Mols. Phenol			Mixture used = 50 Mols. Ani + 50 Mols. Phenol		
t°.	Gms. of Mixture per 100 Gms.		t°.	Gms. of Mixture per 100 Gm	
	Aq. Layer.	A + P Layer.		Aq. Layer.	A. + P Layer
40	5.0	86.0	40	4.0	91.5
60	5.5	82.0	80	5.5	85.5
80	8.0	77.0	100	8.0	82.0
100	12.5	67.0	120	13.5	73.5
110	19.0	56.5	130	19.0	66.0
104 (crit. temp.)	33	...	135	23.5	58.0
			140 (crit. temp.)	35	...

Determinations in above table by "Synthetic Method," see NOTE, p. 77. Schreinemaker gives results for several other mixtures of aniline and phenol which yield curves entirely similar to those for the two mixtures here shown.

## DISTRIBUTION OF ANILINE BETWEEN:

(Vaubel — J. pr. Chem [2] 67, 477, '03.)

Water and Ether.				Water and Carbon Tetrachloride			
Composition of Solutions.		Gms. C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> in:		Composition of Solutions.		Gms. C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> in:	
G. C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> Used.	Solvent.	Aq. Layer.	Ether Layer.	G. C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> Used.	Solvent.	Aq. Layer.	CCl <sub>4</sub> Layer.
1.2478	50 cc. H <sub>2</sub> O			0.3478	50 cc. H <sub>2</sub> O		
	+ 20 cc. Ether	0.1671	1.0807		+ 20 cc. CCl <sub>4</sub>	0.3358	0.06
1.2478	50 cc. H <sub>2</sub> O				50 cc. H <sub>2</sub> O		
	+ 50 cc. Ether	0.0835	1.1643	1.2478	+ 50 cc. CCl <sub>4</sub>	0.2767	1.5
1.2478	50 cc. H <sub>2</sub> O				50 cc. H <sub>2</sub> O		
	+ 100 cc. Ether	0.0594	1.1884	1.2478	+ 100 cc. CCl <sub>4</sub>	0.1845	1.6

## SOLUBILITY OF ANILINE IN SULPHUR.

(Alexejew — Ann. Physik. Chem. 28, 305, '86)

t°.	Gms. C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> per 100 g.		t°.	Gms. C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> per 100 g.	
	S. Layer.	Anilin Layer.		S. Layer.	Anilin Layer.
100	4	75	130	15	58
110	6	70	135	17.5	47
120	10	64	138 (crit. temp.)	23	..

## DISTRIBUTION OF ANILINE BETWEEN WATER AND TOLUENE AT 25°.

(Riedel, 1906)

NOTE. — Mixtures of aniline and toluene were shaken with water and after separation of the two layers the Sp. Gr. of the A : T mixture (layer) was determined and also the amount of aniline in each layer.

Solution Shaken with A : T Mixture.	Vol. per cent Aniline : Toluene in Mixtures Used.	Sp. Gr. of A : T Mixture after Separation.	Gms. C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> in 100 cc	
			A : T Layer.	Aq. Layer
H <sub>2</sub> O	50:50	0.9257	41.5	2.14
"	25:75	0.8928	20.7	1.5
"	12.5:87.5	0.8737	8.62	0.86
"	5.5:94.5	0.8661	3.87	0.45
"	2.5:97.5	0.8627	1.68	0.21

The author also gives data for the distribution of aniline between toluene and aqueous solutions of K<sub>2</sub>SO<sub>4</sub>, KBO<sub>3</sub>, Ba(OH)<sub>2</sub>, Sr(OH)<sub>2</sub> and Ca(OH)<sub>2</sub>.



SOLUBILITY DATA DETERMINED BY THE FREEZING-POINT METHOD (see footnote, page 1) ARE GIVEN FOR MIXTURES OF ANILINE (m. pt.  $-5.5^{\circ}$  to  $-6.8^{\circ}$ ) AND OTHER COMPOUNDS.

Name and M. Pt. of the Other Compound of Each Mixture..	Data for First Eutectic.		Authority.
	M. Pt.	Wt. Per Cent. $C_6H_5NH_2$	
Nitrosodimethyl aniline ( $85.5^{\circ}$ )	- 9.2	94.2 <sup>1</sup>	(Kremann, 1904.)
Benzene ( $5.42^{\circ}$ )	...	...	(Kremann and Borjanovica, 1916.)
Nitrosobenzene ( $63.5^{\circ}$ )	-12.5	77.2	(Kremann, 1904.)
Nitrobenzene ( $2.8^{\circ}$ )	-30.6	53.4	"
o Dinitrobenzene ( $116.5^{\circ}$ )	-10	92.2	(Kremann and Rodinia, 1906.)
" " ( $91^{\circ}$ )	-8	92.7 <sup>2</sup>	(Kremann, 1904.)
" " "	no eutectic		(Kremann and Rodinia, 1906.)
s Trinitrobenzene ( $122.2^{\circ}$ )	not determined <sup>3</sup>		(Kremann, 1904.)
o Chloronitrobenzene ( $32^{\circ}$ )	-19.5	66.1	(Kremann, 1907.)
" " ( $43^{\circ}$ )	-12.6	79.7	(Kremann and Rodinia, 1906.)
" " ( $82.5^{\circ}$ )	-16.3	72.7	"
Benzoic acid ( $121.25^{\circ}$ )	...	...	(Baskov, 1913.)
Chloroform ( $-63^{\circ}$ )	-71	21.7	(Tsakalatos and Guye, 1910.)
o Cresol ( $30.4^{\circ}$ )	-17	78.8 <sup>4</sup>	(Kremann, 1906.)
" " ( $4.2^{\circ}$ )	-30	74.3 <sup>5</sup>	"
" " ( $33.2^{\circ}$ )	-15.5	85.5 <sup>6</sup>	(Kremann, 1906; Philip, 1903.)
Ethylacetate ( $-83.8^{\circ}$ )	...	...	(Wroczynski and Guye, 1910.)
Hydroquinone	89	62	(Kremann and Rodinia, 1906.)
Allyl mustard oil	...	...	{ (Kurnakov and Krist, 1913.) (Kurnakov and Solover, 1916.)
o Chlorophenol	...	...	(Bramley, 1916.)
o Nitrophenol ( $46^{\circ}$ )	-13.5	80.2	(Kremann and Rodinia, 1906.)
" " ( $96^{\circ}$ )	-18.7	74.2 <sup>8</sup>	"
" " ( $113^{\circ}$ )	-17.5	86.8 <sup>9</sup>	"
o Dinitrophenol ( $110.5^{\circ}$ )	-7.3	94.5 <sup>10</sup>	(Kremann, 1906.)
Pyrocatechol ( $105^{\circ}$ )	-13	86.5 <sup>11</sup>	"
Resorcinol ( $110^{\circ}$ )	not determined		((Kremann and Rodinia, 1906.)
Nitrotoluene ( $51.3^{\circ}$ )	-17	89	(Kremann, 1904.)
Dinitrotoluene ( $71^{\circ}$ ), 1.3.4; 1.3.5 } and 1.2.6	-13..	80.8	(Kremann, 1906.)
Trinitrotoluene ( $82^{\circ}$ )	-8	96.4 <sup>12</sup>	
Isopentane (less than $-24^{\circ}$ )	...	...	(Campetti and del Grosso, 1913.)

<sup>1</sup> A second eutectic melts at  $76^{\circ}$  and contains 7 per cent  $C_6H_5NH_2$ , a molecular compound of m. pt.  $92^{\circ}$  and containing 24 per cent  $C_6H_5NH_2$  exists between these eutectics. The author also gives data for the effect of nitrobenzene, o nitrophenol and of m xylene upon the lowering of the m. pt. of the above compound. <sup>2</sup> A break in the curve at  $41.5^{\circ}$  and 39.2 per cent  $C_6H_5NH_2$  indicates that a molecular compound exists between the first eutectic and this point. <sup>3</sup> The first eutectic apparently lies too near pure aniline to be determined. An equi-molecular compound of aniline and s trinitrobenzene (m. pt.  $30^{\circ}$ ) exists over the range pure aniline to the second eutectic which melts at  $101^{\circ}$  and contains 8.7 per cent  $C_6H_5NH_2$ . <sup>4</sup> A second eutectic melts at 0 and contains 28.7 per cent  $C_6H_5NH_2$ , the molecular compound between these points melts at  $8.3^{\circ}$  and contains 46.2 per cent  $C_6H_5NH_2$ . <sup>5</sup> A second eutectic melts at  $-31^{\circ}$  and contains 17 per cent  $C_6H_5NH_2$ , the molecular compound between these points melts at  $-14.6^{\circ}$  and contains 49 per cent  $C_6H_5NH_2$ . <sup>6</sup> The second eutectic melts at  $6^{\circ}$  and contains 23 per cent  $C_6H_5NH_2$ , the molecular compound melts at  $19.2^{\circ}$  and contains 47.5 per cent  $C_6H_5NH_2$ . <sup>7</sup> There are two eutectics between which an equi-molecular combination exists. <sup>8</sup> There is a break in the curve at  $26^{\circ}$  and 42.1 per cent  $C_6H_5NH_2$  indicating the existence of a molecular compound from the eutectic up to this point. <sup>9</sup> There is a break in the curve at  $42^{\circ}$  and 39.8 per cent  $C_6H_5NH_2$  indicating formation of a molecular compound. <sup>10</sup> There is a break in the curve at  $74^{\circ}$  and 32.9 per cent  $C_6H_5NH_2$  indicating the existence of a molecular compound from the eutectic up to this point. <sup>11</sup> There is a break in the curve at  $39^{\circ}$  and 41.9 per cent  $C_6H_5NH_2$ . <sup>12</sup> A second eutectic melts at  $60^{\circ}$  and contains 7 per cent  $C_6H_5NH_2$ , the molecular compounds melts at  $85^{\circ}$  and contains 30 per cent  $C_6H_5NH_2$ .



RECIPROCAL SOLUBILITY OF ANILINE AND HEXANE.  
 (Keyes and Hildebrand, 1917.)

t° of Complete Miscibility.	Gms. Hexane per 100 Gms. Mixture.	t° of Complete Miscibility.	Gms. He. Gms.
26.1	9.6	59.2	3
43.9	14.8	59.4	4
45.9	16.3	59.6	4
49.9	20	57.9	6
51.4	21	53.9	7
56	27.2	47.2	8
58.2	31	35.6	8
58.2	34.6	16.5	9

 RECIPROCAL SOLUBILITY OF ANILINE AND PHENOL, DETERMINED BY  
 FREEZING-POINT METHOD.  
 (Schreinemakers, 1899.)

t° of Melting.	Mols. C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> per 100 Mols. Mixture.	Solid Phase.	t° of Melting.	Mols. C <sub>6</sub> H <sub>5</sub> NH per 100 Mols. Mixture.
- 6.1	100	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub>	30.4 m. pt.	50
- 8.9	96	"	28.6	40
- 11.7 Eutec.	92.3	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> + 1.1	22.3	30
- 6.5	90	1.1	14.8 Eutec.	21.2
+ 10.1	80	"	18.4	20
22	70	"	31.4	10
28.5	60	"	37.3	4



Data for the solubility of aniline in cyclohexane at pressures up to 100 atmospheres are given by Kohnstamm and Timmermans (1913).

 ANILINE HYDROCHLORIDE C<sub>6</sub>H<sub>5</sub>NH<sub>2</sub>.HCl.

100 cc. H<sub>2</sub>O dissolve 17.8 gms. of the salt at 15°. (Niementowski and Rode, 1899.)  
 100 gms. H<sub>2</sub>O dissolve 107.1 gms. of the salt at 25°. (Peddle and Rode, 1900.)  
 100 gms. sat. solution in water contain 52.1 gms. C<sub>6</sub>H<sub>5</sub>NH<sub>2</sub>.HCl at 25°.  
 100 gms. sat. solution in aniline contain 8.89 gms. C<sub>6</sub>H<sub>5</sub>NH<sub>2</sub>.HCl at 25°. (Sidgwick, Pickford and Wilsden, 1911.)

 DISTRIBUTION OF ANILINE HYDROCHLORIDE BETWEEN WATER AND ANILINE.  
 (Sidgwick, Pickford and Wilsden, 1911.)

C <sub>aq.</sub>	C <sub>an.</sub>	C <sub>aq.</sub> /C <sub>an.</sub>	C <sub>aq.</sub>	C <sub>an.</sub>	C <sub>aq.</sub> /C <sub>an.</sub>	C <sub>aq.</sub>	C <sub>an.</sub>
0.11	0.006	19.30	0.6	0.219	2.74	1	0.1
0.2	0.020	10	0.7	0.327	2.14	1.1	1.0
0.3	0.043	6.98	0.8	0.471	1.70	1.2	1.1
0.4	0.086	4.65	0.9	0.631	1.43	1.3	1.2
0.5	0.146	3.42					

C<sub>aq.</sub> = gms. salt per 100 gms. aq. layer. C<sub>an.</sub> = gms. salt per 100 gms. aniline layer.

 NITRANILINES C<sub>6</sub>H<sub>4</sub>NH<sub>2</sub>.NO<sub>2</sub>. *o*, *m*, and *p*.

## SOLUBILITY IN WATER.

(Carmelly and Thomson — J. Chem. Soc. 53, 768, '88; Vaubel — J. pr. Chem. [2] 52, 73, 1898; Löwenherz — Z. physik. Chem. 25, 407, '98.)

t°.	Grams Nitraniline per Liter of Solution.		
	Ortho Nitraniline.	Meta Nitraniline.	Para Nitraniline.
20	...	1.14-1.67	0.77-0.80
24.2	1.25 (25°)	1.205	...
27.3	...	1.422	...

100 cc. H<sub>2</sub>O dissolve 2.2 gms. *p* nitraniline at 100°. (Jaeger and



SOLUBILITY OF ORTHO AND OF META NITRANILINE IN HYDROCHLORIC ACID.

(Lowenherz.)

Ortho Nitraniline at 25°.				Meta Nitraniline.			
G. Mols. per Liter.		Grams per Liter.		G. Mols. per Liter.		Grams per Liter.	
HCl	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> NO <sub>2</sub> (o)	HCl	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> NO <sub>2</sub> (o)	HCl	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> NO <sub>2</sub> (m)	HCl	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> NO <sub>2</sub> (m)
0.0	0.0091	0.0	1.25	(25°) 0.0	0.0091	0.0	1.20
0.63	0.0143	22.97	1.97	(26.5°) 0.0125	0.0183	0.46	2.53
0.95	0.0174	34.63	2.40	(23.3°) 0.0247	0.0274	0.90	3.85
1.26	0.0215	45.94	2.97				

SOLUBILITY DATA DETERMINED BY THE FREEZING-POINT METHOD ARE GIVEN FOR THE FOLLOWING MIXTURES.

o Nitraniline + m Nitraniline	}	(Kremann, 1910; Valetton, 1910; Holleman, Hartogs and van der Linden, 1911, Nichols, 1918.)
o " + p "		
m " + p "	}	(Jaeger, 1906.)
o " + o Nitracentanilide		
p " + p Nitrosoaniline	}	(Jaeger and van Kregten, 1912.)
" " + Benzene		
" " + "	"	"
p " + "	"	"
o " + Nitrobenzene	"	"
m " + "	"	"
p " + "	"	"
o " + Ethylenebromide	"	"
m " + "	"	"
p " + "	"	"
m " + m Dinitrobenzene	(Crompton and Whitely, 1895.)	
m " + s Trinitrobenzene	(Smith and Walts, 1910; Sudborough and Beard, 1910.)	
p " + s "	"	"
m " + Naphthalene	(Pushin and Grebenschikov, 1913.)	
o " + Phenol	(Kremann and Rodinis, 1906.)	
m " + "	"	"
p " + "	"	"
s Tribromaniline + 2 Chlor, 4,6 Dibromaniline	(Sudborough and Lakhamalani, 1917.)	
p Nitroethylaniline + p Nitrosoethylaniline	(Jaeger and van Kregten, 1912.)	
p " propylaniline + p Nitrosopropylaniline	"	
Nitrodiethylaniline + Nitrosodiethylaniline	(Jaeger, 1905, 1907.)	
Methylaniline + Benzylchloride	(Wroczynski and Guye, 1910.)	
Dimethylaniline + Benzene	(Schmidlin and Lang, 1912.)	
" + Tetramethyldiaminobenzophenone	"	
" + Phenol	(Bramley, 1916; Kremann, 1906.)	
" + o Chlorophenol	(Bramley, 1916.)	
Tetranitromethylaniline + α Trinitrotoluene	(Gius, 1915.)	
" + p Nitrotoluene	"	
Nitrosodimethylaniline + β Naphthylamine	(Kremann, 1904.)	
" + Phenol	"	
" + o Toluidine	"	
" + p "	"	
" + m Xylidine	"	



SOLUBILITY OF META AND OF PARA NITRANILINE IN ORGANIC  
SOLVENTS AT 20°.  
(Carnelly and Thomson.)

Solvent.	Gms. per Liter.		Solvent.	Gms. per Meta.
	Meta.	Para.		
Methyl Alcohol	110.6	95.9	Benzene	24.5
Ethyl Alcohol	70.5	58.4	Toluene	17.1
Propyl Alcohol	56.5	43.5	Cumene	11.5
Iso Butyl Alcohol	26.4	19.1	Chloroform	30.1
Iso Amyl Alcohol	85.1	62.9	Carbon Tetra Chloride	2.1
Ethyl Ether	78.9	61.0	Carbon Disulfide	3.3

**ANILINE SULFATE**  $C_6H_5NH_2 \cdot H_2SO_4$ .100 cc.  $H_2O$  dissolve 6.6 gms.  $C_6H_5NH_2 \cdot H_2SO_4$  at 15°.

(Niementowski and Roszkowski,

**ANISIC ACID** (*p*-Methoxybenzoic Acid)  $CH_3O \cdot C_6H_4COOH$ .

1000 cc. sat. aqueous solution contain 0.2263 gm. acid at 25°. (Paul,

SOLUBILITY OF ANISIC ACID IN SEVERAL ALCOHOLS.  
(Timofeiew, 1894.)

In Methyl Alcohol.			In Ethyl Alcohol.			In Propyl Alk		
t°.	Gms. per 100 Gms.		Gms. per 100 Gms.		t°.	Gms. per 100 G.		t°.
	Sat. Sol.	Solvent.	Sat. Sol.	Solvent.		Sat. Sol.	Solv.	
0	51.1	104.5	46.7	87.6		35	53	
16.5	64.9	183.5	53.6	115.5		43	75	

Data for the distribution of anisic acid between water and olive oil a are given by Böseken and Waterman (1911, 1912).

*p* **ANISIDINE**  $C_6H_4(OCH_3) \cdot NH_2$ .

## DISTRIBUTION BETWEEN BENZENE AND WATER AT 25°.

(Farmer and Warth, 1904.)

Gms.  $C_6H_4(OCH_3) \cdot NH_2$  per 100 cc.

$C_6H_6$ Layer.	$H_2O$ Layer.
0.4356	0.0747
0.6662	0.1112
0.9010	0.1472

**ANISOLE**  $C_6H_5OCH_3$ .

RECIPROCAL SOLUBILITY OF ANISOLE AND BENZYL CHLORIDE DETERM  
BY THE FREEZING-POINT METHOD.

(Wroczyński and Guye, 1910.)

t° of Melting.	Gms. $C_6H_5(OCH_3)$ per 100 Gms. Mixture.	Solid Phase.	t° of Melting.	Gms. $C_6H_5OCH_3$ per 100 Gms. Mixture.	Solid Phase.
-37.2	100	$C_6H_5OCH_3$	-72.8 Eutec.	46.1	$C_6H_5OCH_3 + C_6H_5CH_2Cl$
-40	93.3	"	-60	28	$C_6H_5CH_2Cl$
-50	75.3	"	-50	13	"
-60	62.1	"	-41.1	0	"

*p* Nitr**ANISOLE**  $C_6H_4NO_2 \cdot OCH_3$ .

FREEZING-POINT CURVES (Solubilities, see footnote, page 1) ARE GIVEN  
THE FOLLOWING MIXTURES.

<i>p</i> Nitranisole	+ Mercuric Chloride	(Mascarelli, 1906, 1909; Mascarelli and Ascoli, 1907)
"	+ Urethan	(Mascarelli, 1906, 1909; Pushan and Grebenschnitov, 1913.)
"	+ " + $HgCl_2$	(Mascarelli, 1906, 1909.)
"	+ Diphenylamine	(Pushan and Grebenschnitov, 1913.)
Dinitranisole	+ Dinitrophenetol	(Blankens, 1914.)



ANTHRACENE  $C_{14}H_{10}$ 

## SOLUBILITY OF ANTHRACENE IN SEVERAL SOLVENTS.

Solvent.	t°	Gms. $C_{14}H_{10}$ per 100 Gms. Solvent.	Authority.
Alcohol (abs.)	16	0.076	(v. Becchi.)
"	19.5	1.9	(de Bruyn. 1892.)
"	25	0.328	(Hildebrand, Ellefson and Beebe, 1917.)
"	b. pt.	0.83	(v. Becchi.)
ethyl Alcohol (abs.)	19.5	1.8	(de Bruyn 1892.)
benzene	25	1.86	(Hildebrand, Ellefson and Beebe, 1917.)
carbon Disulphide	25	2.58	" " "
carbon Tetrachloride	25	0.732	" " "
chloroform	25	1.42	" " "
hexane	25	0.37	" " "
% Formic Acid	18.3	0.03	(Aschan, 1913.)
toluene	16.5	0.92	(v. Becchi.)
"	100	12.94	"
dichloroethylene	15	1.01	(Wester and Bruins, 1914.)

## SOLUBILITY OF ANTHRACENE IN BENZENE AND IN MIXTURES OF BENZENE AND PENTANE AND OF BENZENE AND HEPTANE.

(Tyrer, 1910, and private communication. See Note, p. 447.)

In Benzene.		In Benzene + Pentane at 15°.		In Benzene + Heptane at 14° and 70°.		
d. of Sat. Sol.	Gms. $C_{14}H_{10}$ per 100 Gms. Solvent.	% $C_6H_6$ in Solvent.	Gms. $C_{14}H_{10}$ per 100 Gms. Solvent.	% $C_6H_6$ in Solvent.	Gms. $C_{14}H_{10}$ per 100 Gms. Solvent at 14°.	at 70°.
0.0008	0.605	0	0.184	0	0.210	1.67
0.8009	0.975	10	0.225	12.5	0.284	2.10
0.8812	1.43	20	0.279	25	0.372	2.64
0.8717	2.03	30	0.357	37.5	0.474	3.23
0.8627	2.78	40	0.447	50	0.592	3.87
0.8541	3.75	50	0.549	62.5	0.718	4.59
0.8460	5.14	60	0.600	75	0.850	5.37
0.8374	7	70	0.780	87.5	0.976	6.15
0.8347	8.35	80	0.915	100	1.180	6.93
		90	1.059			
		100	1.225			

results for the solubility in benzene, differing from the above in some cases by 1%, are given by Findlay (1902).

## SOLUBILITY OF ANTHRACENE IN ALCOHOLIC PICRIC ACID SOLUTIONS AT 25°.

(Behrend — Z. physik. Chem. 15, 187, '94.)

Gms. per 100 Grams Solution.		Grams per 100 Gms. Solution.		Solid Phase.
Anthracene.		Picric Acid.	Anthracene.	
0.176	Anthracene	3.999	0.202	Anthracene Picrate
7 0.190	"	5.087	0.180	"
1 0.206	"	5.843	0.162	"
3 0.215	"	6.727	0.151	"
3 0.228	"	7.511	0.149	Anthracene Picrate + Picric Acid
9 0.236	Anthracene and Anthracene Picrate	7.452	0	Picric Acid



# ANTHRACENE

82

## SOLUBILITY IN LIQUID SULFUR DIOXIDE IN THE CRITICAL REGION. (Centnerswer and Teletow, 1903.)

Weighed amounts of anthracene and liquid  $\text{SO}_2$  were placed in glass tubes which were sealed and rotated at a gradually increasing temperature, and the point observed at which the solid disappeared.

t°.	Gms. $\text{C}_{14}\text{H}_{10}$ per 100 Gms. $\text{SO}_2$ .	t°.	Gms. $\text{C}_{14}\text{H}_{10}$ per 100 Gms. $\text{SO}_2$ .	t°.	Gms. $\text{C}_{14}\text{H}_{10}$ per 100 Gms. $\text{SO}_2$ .
40.1	2.11	65	4	98	9.36
45.8	2.48	78.2	5.66	99.1	9.95
47.9	2.65	88	7.14	106.5	12.78

Freezing-point curves are given for mixtures of anthracene and each of the following compounds: Diphenyl, diphenylamine,  $\alpha$  and  $\beta$  naphthylamines,  $\alpha$  and  $\beta$  naphthols, resorcinol, *p* toluidine and triphenyl methane (Vignon, 1891); Naphthalene (Vignon and Miolati, 1892); Phenanthrene (Vignon, 1891, Garelli, 1894); Picric acid (Kremann, 1905).

# ANTHRAQUINONE ( $\text{C}_{14}\text{H}_8(\text{CO})_2$ ).

## SOLUBILITY IN LIQUID SULFUR DIOXIDE IN THE CRITICAL REGION. (Centnerswer and Teletow, 1908.) (See Anthracene, above.)

t°.	Gms. $\text{C}_{14}\text{H}_8\text{O}_2$ per 100 Gms. $\text{SO}_2$ .	t°.	Gms. $\text{C}_{14}\text{H}_8\text{O}_2$ per 100 Gms. $\text{SO}_2$ .	t°.	Gms. $\text{C}_{14}\text{H}_8\text{O}_2$ per 100 Gms. $\text{SO}_2$ .
3.96	0.64	92.1	2.81	118.5	5.60
51.5	0.88	101.4	3.67	141.6	7.53
67.9	1.73	106.3	4.23	160	9.60
82.4	2.24	108.7	4.40	179	12.70
				183.7	18.30

100 parts of absolute ethyl alcohol dissolve 0.05 part anthraquinone at 18° and 2.249 parts at b. pt. (v. Becchi.)

100 gms. alcohol dissolve 0.437 gm. anthraquinone at 25°.

(Hildebrand, Elletson and Beebe, 1917.)

## SOLUBILITY OF ANTHRAQUINONE IN BENZENE AND IN CHLOROFORM. (Tyrer, 1910.)

In Benzene.			In Chloroform.		
t°.	Sp. Gr. Solution.	Gms. $\text{C}_{14}\text{H}_8\text{O}_2$ per 100 Gms. $\text{C}_6\text{H}_6$ .	t°.	Sp. Gr. Solution.	Gms. $\text{C}_{14}\text{H}_8\text{O}_2$ per 100 Gms. $\text{CHCl}_3$ .
0	0.8900	0.110	0	1.5244	0.340
20	0.8794	0.256	10	1.5046	0.457
30	0.8692	0.350	20	1.4850	0.605
40	0.8591	0.495	30	1.4656	0.780
50	0.8439	0.700	40	1.4461	0.994
60	0.8389	0.974	50	1.4261	1.256
70	0.8288	1.355	55	1.4164	1.415
80	0.8190	1.775	60	1.4070	1.577

## SOLUBILITY OF ANTHRAQUINONE IN A MIXTURE OF CHLOROFORM AND HEXANE AT 12.6° AND 49°.

(Tyrer, 1910, also private communication. See Note, p. 447.)

% $\text{CHCl}_3$ in Solvent.	Gms. $\text{C}_{14}\text{H}_8\text{O}_2$ per 100 Gms. Solvent at:		% $\text{CHCl}_3$ in Solvent.	Gms. $\text{C}_{14}\text{H}_8\text{O}_2$ per 100 Gms. Solvent at:	
	12.6°.	49.0°.		12.6°.	49.0°.
0	0.006	0.056	60	0.101	0.292
10	0.016	0.074	70	0.148	0.417
20	0.024	0.096	80	0.222	0.608
30	0.034	0.124	90	0.334	0.852
50	0.068	0.212	100	0.482	1.209



## SOLUBILITY OF ANTHRAQUINONE IN ETHER.

(Smits — Z. Electrochem. 9, 663, '03.)

Weighed amounts of ether and anthraquinone were placed in glass tubes which were then sealed. The temperature noted at which the anthraquinone disappeared and also at which the liquid phase disappeared (critical temp.). The two curves cross at 195° and again at 241°. Between these two temperatures the critical curve lies below the solubility curve, hence for this range of temperature no solubility curve is shown. The following figures were read from the curves, and are therefore only approximately correct.

t°.	Gms. $C_{14}H_{10}O_2$ per 100 g. Solution.	t°.	Gms. $C_{14}H_{10}O_2$ per 100 g. Solution.	t°.	Gms. $C_{14}H_{10}O_2$ per 100 g. Solution.
130	3	241	30	260	80
150	4	245	40	270	90
170	4.5	247	50	275	100
195	5.0	250	60		

100 parts of toluene dissolve 0.19 part anthraquinone at 15° and 5.56 parts at 100° (v. Becchi).

100 gms. ether dissolve 0.104 gm. anthraquinone at 25°.

(Hildebrand, Ellefson and Beebe, 1917.)

Data for the solubility of anthraquinone in mixtures of phenol and water are given by Timmermanns (1907).

Hydroxy ANTHRAQUINONES  $C_6H_4 < (CO)_2 > C_6H_4OH$ .

1000 cc.  $H_2O$  dissolve 0.0035 gm.  $\alpha$  oxyanthraquinone at 25°. (Hüttig, 1914.)

1000 cc.  $H_2O$  dissolve 0.0011 gm.  $\beta$  oxyanthraquinone at 25°. " "

1000 cc.  $H_2O$  dissolve 0.000012–0.000062 gm. 1.4 dioxyanthraquinone (= chinizarin) at 25°.

1000 cc.  $H_2O$  dissolve 0.00158 gm. 1.6 dioxyanthraquinone (= chrysazin) at 25°.

(Hüttig, 1914.)

ANTHRAFLAVINE (2.6 Dioxyanthraquinone)  $C_{13}H_6(CO)_2(OH)_2$ .

1000 cc.  $H_2O$  dissolve 0.0003 gm. anthraflavine at 25°. (Hüttig, 1914.)

ANTHRARUFINE (1.5 Dioxyanthraquinone)  $C_{13}H_6(CO)_2(OH)_2$ .

1000 cc.  $H_2O$  dissolve 0.000285 gm. anthrarufine at 25°. (Hüttig, 1914.)

## ANTIMONY Sb.

Fusion-point data for mixtures of antimony and iodine are given by Jaeger and Dornbosch (1912); for mixtures of antimony and sulphur by Jaeger and Van Klooster (1912), and for mixtures of antimony, iodine and arsenic by Quercigh (1912).

ANTIMONY TRIBROMIDE  $SbBr_3$ .

## SOLUBILITY IN BENZENE DETERMINED BY "SYNTHETIC METHOD."

(Menschutkin, 1910.)

t°	Gms. $SbBr_3$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $SbBr_3$ per 100 Gms. Sat. Sol.	Solid Phase.
5.6 m. pt.	0	$C_6H_6$	90	83	$2SbBr_3 \cdot C_6H_6$
4.5 Eutec.	8.3	$C_6H_6 + 2SbBr_3 \cdot C_6H_6$	92.5 m. pt.	90.2	"
15	12.5	$2SbBr_3 \cdot C_6H_6$	91.5	92.8	"
35	23	"	90	93.8	"
55	39	"	85 Eutec.	96.3	$2SbBr_3 \cdot C_6H_6 + SbBr_3$
75	60.5	"	90	98	$SbBr_3$
85	74.3	"	94	100	"



RECIPROCAL SOLUBILITIES OF ANTIMONY TRIBROMIDE AND VARIOUS  
ORGANIC COMPOUNDS, DETERMINED BY THE "SYNTHETIC METHOD."  
(Menschutkin, 1911.)

SbBr <sub>3</sub> + Acetic Acid.		SbBr <sub>3</sub> + Benzoic Acid.		SbBr <sub>3</sub> + Benzoyl Chloride.		SbBr <sub>3</sub> + Benzenesulphonic Acid.	
t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.
16.5 *	0	120 *	0	- 0.5 *	0	52.5 *	0
15	12.2	115	20.1	- 3	19.5	50	15.8
10	41.8	110	36.8	- 6 †	32	47.5	26.2
4 †	58.2	105	50	+ 10	41.2	44 †	36.9
20	64.3	100	61.5	20	47.5	50	39.1
40	72.5	95	71	30	54	60	45.7
60	81.9	85	83.1	40	60.8	70	55.2
70	97.1	79 †	87.6	50	67.8	80	68.1
80	92.4	85	92	60	74.9	85	77.6
90	97.8	90	96.4	80	89.4	90	90.3
94	100	94	100	94	100	94	100

Molecular compounds are not formed in the above systems. The diagram in each case consists of two arms meeting at the eutectic.

SbBr <sub>3</sub> + Acetophenone.			SbBr <sub>3</sub> + Amylbenzene.			SbBr <sub>3</sub> + Anisole.		
t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
19.5 *	0	C <sub>6</sub> H <sub>5</sub> COCH <sub>3</sub>	- 70	4.5	SbBr <sub>3</sub> .C <sub>10</sub> H <sub>13</sub> .C <sub>6</sub> H <sub>11</sub>	- 34 *	0	C <sub>6</sub> H <sub>5</sub> OC <sub>2</sub> H <sub>5</sub>
15	22.7	"	- 50	8.3	"	- 35	2.5	" + 1.1
1.5 *	48.6	" + 1.1	- 30	16.6	"	- 20	11.7	1.1
20	56.8	1.1	- 25	21	"	0	26.5	"
30	63.3	"	- 17 †	32.5	" + SbBr <sub>3</sub>	10	37.1	"
37.5 *	75	"	- 10	33.5	SbBr <sub>3</sub>	20	50.5	"
31 †	83.2	1.1 + SbBr <sub>3</sub>	0	35.6	"	25	59	"
40	84.6	SbBr <sub>3</sub>	20	41.6	"	30.5 *	77	"
60	88.4	"	40	51.3	"	30 †	77.9	" + SbBr <sub>3</sub>
80	94.1	"	60	65	"	40	80.6	SbBr <sub>3</sub>
94	100	"	80	84	"	60	86.4	"
						80	93.6	"

SbBr <sub>3</sub> + Benzaldehyde.			SbBr <sub>3</sub> + Benzonitrile.			SbBr <sub>3</sub> + Benzophenone.		
t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
- 20	38.4	1.1	- 13.2 *	0.0	C <sub>6</sub> H <sub>5</sub> CN	48 *	0	C <sub>6</sub> H <sub>5</sub> CO.C <sub>6</sub> H <sub>5</sub>
0	45.5	"	- 16	19.2	"	40	24	"
20	54.3	"	- 18 †	28.7	" + 1.1	29 †	41.2	" + 1.1
35	64.1	"	0	43	1.1	40	50	1.1
40	70.3	"	20	59	"	45	56.3	"
41.5 *	77.2	"	30	67	"	48.5 *	66.4	"
37.8 †	84.4	1.1 + SbBr <sub>3</sub>	38 *	77.8	"	45	76	"
55	88	SbBr <sub>3</sub>	35 †	82.5	1.1 + SbBr <sub>3</sub>	40	80	1.1 + SbBr <sub>3</sub>
75	93.1	"	55	87.5	SbBr <sub>3</sub>	50	82.6	SbBr <sub>3</sub>
85	96.1	"	75	93.3	"	70	88.7	"
90	98.2	"	85	96.5	"	80	92.4	"
94	100	"	90	98.3	"	90	97.3	"
			94	100	"	94	100	"

\* m. pt.

† Eutec.

‡ tr. pt.

1.1 = compound of equimolecular amounts of the two constituents in each case



RECIPROCAL SOLUBILITIES OF ANTIMONY TRIBROMIDE AND VARIOUS ORGANIC COMPOUNDS, DETERMINED BY THE "SYNTHETIC METHOD."

(Menschutkin, 1910.)

SbBr <sub>3</sub> + Brombenzene.		SbBr <sub>3</sub> + Chlorbenzene.		SbBr <sub>3</sub> + Iodobenzene.		SbBr <sub>3</sub> + Fluorbenzene.	
t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.
-31*	0	-45.2*	0	-28.6*	0	-39.2*	0
-32	5.7	-47†	5.2	-30.3	7.0	-39.5†	1.3
-35†	9.5	-40	6.8	-32†	14.3	-25	4.3
-15	15	-30	9.6	-20	21.6	-15	6.7
-5	20.8	-20	12.6	-10	27.5	+5	12.6
+5	26.8	-10	16	0	33.4	25	21.8
15	33	0	20	+10	39.3	45	35.3
25	39.6	20	30	20	45.2	55	45.5
45	54.6	40	45.4	40	57.6	65	60.8
65	71.9	60	65.8	60	71.1	75	81.8
85	90.7	80	86.3	80	86.3	85	93.5
94	100	94	100	94	100	94	100

SbBr <sub>3</sub> + <i>p</i> -Dibrombenzene.		SbBr <sub>3</sub> + <i>p</i> -Dichlorbenzene.		SbBr <sub>3</sub> + Nitrobenzene.		SbBr <sub>3</sub> + <i>m</i> -Dinitrobenzene.	
t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.
88*	0	54.5*	0	6*	0	90*	0
85	10	51.5	14	1	22	80	29.1
80	25.2	48.5†	26.5	-4	37.4	70	50
75	39.2	55	35.9	-9	48.4	60	63
70	52	60	43.1	-14.5†	55.3	50	70.8
65†	62.2	65	50.7	-5	58.3	47.5†	72
70	68.7	70	58.8	+5	61.5	50	73.4
75	75.3	75	67.2	25	68.6	60	78.2
80	81.8	80	75.8	45	76.6	70	84
85	88.3	85	84.5	65	85.3	80	90.4
90	94.3	90	93.4	85	94.7	90	96.8
94	100	94	100	94	100	94	100

Molecular compounds are not formed in the above systems. The diagram in each case consists of two arms meeting at the eutectic.

SbBr <sub>3</sub> + Ethylbenzene.			SbBr <sub>3</sub> + Propylbenzene.			SbBr <sub>3</sub> + <i>p</i> -Cymene.		
t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-93*	0	C <sub>6</sub> H <sub>5</sub> .C <sub>2</sub> H <sub>5</sub>	-80	1.3	1.1	-75*	0	
-93.2†	0.4	" + 1.1	-60	3.7	"	-77†	2	
70	1	1.1	-40	9.4	"	-50	6.1	1.1
50	2.2	"	-20	22.5	"	-30	12.3	"
30	4.8	"	-10	38.4	"	-10	27	"
10	12	"	-5†	49	1.1 + SbBr <sub>3</sub>	0	42.3	"
10	20.2	"	+10	53.3	SbBr <sub>3</sub>	+5†	51.5	1.1 + SbBr <sub>3</sub>
20	46.3	"	20	57.1	"	20	56	SbBr <sub>3</sub>
29†	69.7	1.1 + SbBr <sub>3</sub>	40	66.2	"	40	64.1	"
50	78.2	SbBr <sub>3</sub>	60	77.2	"	60	75	"
70	87.3	"	80	89.8	"	80	88.5	"
90	97.7	"	94	100	"	94	100	"

\* m. pt.

† Eutec.

‡ tr. pt.

1.1 = compound of equimolecular amounts of the two constituents in each case.



## RECIPROCAL SOLUBILITIES OF ANTIMONY TRIBROMIDE AND VARIOUS (COMPOUNDS, DETERMINED BY THE "SYNTHETIC METHOD."

(Menschutkin, 1911.)

SbBr <sub>3</sub> + Cyclohexane.			SbBr <sub>3</sub> + Pseudo Cymene.			SbBr <sub>3</sub> + Mesityl		
t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	S
6.4 *	0	C <sub>6</sub> H <sub>12</sub>	-57.2 *	0	C <sub>6</sub> H <sub>8</sub> (CH <sub>3</sub> ) <sub>1,2,4</sub>	-54.4 *	0	C <sub>6</sub> H <sub>6</sub> (C
6 †	0.3	C <sub>6</sub> H <sub>12</sub> +SbBr <sub>3</sub>	-58.8 †	9.7	" +1.1	-55.2 †	2.1	" +
20	1.4	SbBr <sub>3</sub>	-50	11	1.1	-30	3.6	
40	3.7	"	-30	16.2	"	-10	9	
60	7.1	"	-10	31	"	+10	25.4	
80	12.5	"	0	47.6	"	20	35.5	
liquid layers formed			7 ‡	63.5	1.1+2.1	29 ‡	46.5	1.1
92.5	17.4	97.6	15	67.4	2.1	40	54.2	
110	25.8	96.5	25	73	"	50	61.7	
130	36.4	95	33 ‡	79.1	2.1+SbBr <sub>3</sub>	60	70.2	
150	47.8	92.7	50	82.8	SbBr <sub>3</sub>	69.5 *	85.8	
170	62.3	86.3	70	88.4	"	69 †	87.7	2.1
175 †		74.0	90	97.4	"	80	92.7	5

SbBr<sub>3</sub> + Diphenylmethane. SbBr<sub>3</sub> + Naphthalene. SbBr<sub>3</sub> +  $\alpha$  Nitronapl

t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	
26 *	0	CH <sub>2</sub> (C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub>	79.4 *	0	C <sub>10</sub> H <sub>8</sub>	57 *	0.0	$\alpha$
22.5 †	12.8	" +2.1	75	23.7	"	50	23.2	
40	22.8	2.1	70	37.4	"	40	42.6	
50	29.5	"	65	48.6	"	33.5 †	50.5	
60	37.5	"	57	61.2	" +2.1	37.5	62.6	
70	47.8	"	60	68	2.1	38.2 *	67.6	
80	60.2	"	65	81.3	"	38 †	68	1.
90 *	81.1	"	66 *	84.9	"	50	73.4	
85	89.6	"	65 †	86.7	2.1+SbBr <sub>3</sub>	70	83.8	
82 †	92.2	2.1+SbBr <sub>3</sub>	75	90.1	SbBr <sub>3</sub>	90	96.4	
90	96.2	SbBr <sub>3</sub>	85	94.9	"			
94	100	"	90	97.7	"			

SbBr <sub>3</sub> + Diphenyl.			SbBr <sub>3</sub> + Phenol.			SbBr <sub>3</sub> + Phen		
t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	
70.5 *	0	C <sub>6</sub> H <sub>5</sub> C <sub>6</sub> H <sub>5</sub>	41 *	0	C <sub>6</sub> H <sub>5</sub> OH	-28.6 *	0	C
60	35.7	"	35	22.5	"	-29 †	1.6	
50	54.3	"	30	40	"	-10	4.8	
47 †	57.4	" +2.1	28.5 †	44.6	" +2.1	+10	12.9	
55	68.5	2.1	40	53	2.1	20	19.2	
60.5 *	82.7	"	50	62.5	"	30	29.7	
70	86.5	SbBr <sub>3</sub>	60	75.8	"	40	46.2	
80	91.5	"	65	84.7	"	48.8 *	74.7	
90	97.3	"	66.5 *	88.5	"	47 †	77.8	
94	100	"	75	91.7	SbBr <sub>3</sub>	60	83	
			85	95.8	"	70	87.3	
			90	98.1	"	90	97.4	

\* m. pt.

† Eutec.

‡ crit. t.

§ tr. pt.

¶ Not obtained regularly, in such cases, single eutectic at 23° and 61.5 per cent SbI

1.1 = compound of equimolecular amounts of the two constituents in e

2.1 = compound of 2 molecules of SbBr<sub>3</sub> with one molecule of the o  
stituent.



RECIPROCAL SOLUBILITIES OF ANTIMONY TRIBROMIDE IN VARIOUS ORGANIC COMPOUNDS, DETERMINED BY THE "SYNTHETIC METHOD."

(Menschutkin, 1910-12.)

SbBr <sub>3</sub> + $\alpha$ Brom-naphthalene.		SbBr <sub>3</sub> + $\alpha$ Chlor-naphthalene.		SbBr <sub>3</sub> + $\beta$ Chlor-naphthalene.		SbBr <sub>3</sub> + Tetrahydrobenzene.	
t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.
3°	0	-17°	0	56°	0	...	...
0	15.8	-21°	13.8	50	26.1	-5	11.7
-3.5†	31.4	-24.5†	22.6	45	38.5	15	15.1
15	38.7	-10	27.3	40	49	35	24.1
35	49.9	+10	35.5	37.5†	53.6	55	41
45	56.9	30	46.7	45	58.8	65	55.1
55	64.7	50	61.6	55	66.8	70	64.5
65	72.9	60	69.9	65	75.2	75	76.2
75	81.8	70	78.6	75	83.8	80	84.4
80	86.3	80	87.5	80	88.1	85	90.7
85	90.8	90	96.6	85	92.4	90	95.8
90	95.4	94	100	90	96.7	94	100

SbBr <sub>3</sub> + <i>o</i> Chlorotoluene.		SbBr <sub>3</sub> + <i>m</i> Chlorotoluene.		SbBr <sub>3</sub> + <i>p</i> Chlorotoluene.		SbBr <sub>3</sub> + Nitrobenzene.	
t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.
-36.2°	0	-47.8°	0	6.2°	0	16°	0
-38.5†	10.7	-50†	8.1	2.5†	23.3	10	24.2
-20	15.4	-30	11.7	20	33	5	39
0	22.5	-10	17.5	30	39.3	0	46.6
+20	32.5	+10	25.8	40	47.2	-9†	56.8
30	38.8	30	37.5	50	56.3	+10	62.7
40	46.8	40	45.1	60	66.7	30	69.7
50	56	50	54.4	70	77.8	50	77.5
60	66.5	60	65	80	88.2	60	81.5
70	77.8	70	77	90	97	70	86.3
80	88.2	80	88.2	94	100	80	91.4
90	97	90	97			90	97.2

Molecular compounds are not formed in the above systems. The diagram in each case consists of two arms meeting at the eutectic.

SbBr <sub>3</sub> + Toluene.			SbBr <sub>3</sub> + <i>o</i> Nitrotoluene.			SbBr <sub>3</sub> + <i>p</i> Nitrotoluene.		
t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-93°	0	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub>	-8.5°	0	<i>o</i> NO <sub>2</sub> .C <sub>6</sub> H <sub>4</sub> .CH <sub>3</sub>	52.5°	0	<i>p</i> NO <sub>2</sub> .C <sub>6</sub> H <sub>4</sub> .CH <sub>3</sub>
-93.5†	1.0	" +1.1	-13.5	19.5	" +1.1	45	29.8	"
80	2.4	1.1	0	27.6	1.1	40	42.2	"
60	6.2	"	10	35.6	"	35	50	"
40	12.4	"	20	47.5	"	25	61	"
20	25.7	"	25	55.7	"	16†	67	" +SbBr <sub>3</sub>
1°	53.1	1.1 + 2.1	31†	70	" +SbBr <sub>3</sub>	30	71.6	SbBr <sub>3</sub>
20	69.4	2.1	40	73.5	SbBr <sub>3</sub>	50	78.9	"
30†	78	2.1 + SbBr <sub>3</sub>	50	77.5	"	60	82.9	"
40	80.6	SbBr <sub>3</sub>	60	81.7	"	70	87.2	"
50	86.6	"	80	91.4	"	80	92	"
60	93.8	"	90	97.2	"	90	97.5	"
100	100							

\* m. pt.

† Eutec.

‡ tr. pt.

1.1 = compound of equimolecular amounts of the two constituents in each case.  
2.1 = compound of 2 molecules of SbBr<sub>3</sub> with 1 molecule of the other constituent.



RECIPROCAL SOLUBILITIES OF ANTIMONY TRIBROMIDE AND VARIOUS  
COMPOUNDS, DETERMINED BY THE "SYNTHETIC METHOD."

(Menschutkin, 1910-11.)

SbBr <sub>3</sub> + Tri-phenylmethane.		SbBr <sub>3</sub> + <i>o</i> Xylene.		SbBr <sub>3</sub> + <i>m</i> Xylene.		SbBr <sub>3</sub> +	
t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbBr <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	
92 *	0	-29 *	0	-57 *	0	14 *	
85	18	-33 †	10.5	-59.2 †	5.5	12	
80	30.1	-20	17	-45	10	10 †	
70	47	-10	24.6	-35	14.2	20	
60	58.2	0	34.5	-25	20	30	
48 †	67.1	20	65.8	-5	38.8	40	
60	73.3	24 *	77.2	+5	56.6	50	
70	79.5	22.5 †	78.6	12.5 ‡	75.4	60	
80	86.4	30	80	25	77.6	67.5 *	
90	95.2	50	84.7	45	82.3	66.5 †	
94	100	70	90.1	65	87.9	75	
		90	97.7	87	95.3	85	

\* m. pt.

† Eutec.

‡ tr. pt.

In the case of each of the above xylenes the compound existing between the first and second eutectic consists of equimolecular amounts of SbBr<sub>3</sub> and

Solubility data determined by the freezing-point method (see footnote) are given for mixtures of antimony tribromide and each of the following compounds: azobenzene, benzil, *s* diphenylethane and stilbene (Van Stone, 1914), azophenone, triphenylmethane and toluene. (Kurakov, Krotkov and O

ANTIMONY TRICHLORIDE SbCl<sub>3</sub>.SOLUBILITY IN WATER. SOLID PHASE SbCl<sub>3</sub>.

(Meerburg — Z. anorg. Chem. 33, 299, 1903.)

t°.	Mols. SbCl <sub>3</sub> per 100 Mols. H <sub>2</sub> O.	Gms. SbCl <sub>3</sub> per 100 g. H <sub>2</sub> O.	t°.	Mols. SbCl <sub>3</sub> per 100 Mols. H <sub>2</sub> O.
0	47.9	601.6	35	91.6
15	64.9	815.8	40	108.8
20	{ 72.4	910.1	50	152.5
	{ 74.1	931.5	60	360.4
25	78.6	988.1	72	∞
30	84.9	1068.0		

SOLUBILITY OF ANTIMONY TRICHLORIDE IN AQUEOUS HYDROCHLORIC  
ACID. SOLID PHASE SbCl<sub>3</sub>. TEMP. 20°.

(Meerburg.)

Mols. per 100 Mols. H <sub>2</sub> O.		Gms. per 100 g. H <sub>2</sub> O.		Mols. per 100 Mols. H <sub>2</sub> O.		HCl
HCl.	SbCl <sub>3</sub> .	HCl.	SbCl <sub>3</sub> .	HCl.	SbCl <sub>3</sub> .	
0	72.4	0.0	910.1	9.1	68.9	18.
2.4	71.2	4.86	895.4	11.7	68.1	23.
6.1	69.9	12.34	879.0	28.7	62.8	58.
8.3	68.2	16.80	857.6			

100 gms. absolute acetone dissolve 537.6 gms. SbCl<sub>3</sub> at 18°. *d*<sub>4</sub> sat. sol. (Na)

100 gms. ethyl acetate dissolve 5.9 gms. SbCl<sub>3</sub> at 18° *d* sat. sol. = 1 (Na)



# RECIPROCAL SOLUBILITIES OF ANTIMONY TRICHLORIDE AND VARIOUS ORGANIC COMPOUNDS, DETERMINED BY THE "SYNTHETIC METHOD."

(Menschutkin, 1911.)

SbCl <sub>3</sub> + Acetic Acid.			SbCl <sub>3</sub> + Acetophenone.			SbCl <sub>3</sub> + Anisol.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid P. ase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
16.5*	0	CH <sub>3</sub> COOH	19.5*	0	C <sub>6</sub> H <sub>5</sub> COCH <sub>3</sub>	-34*	0	C <sub>6</sub> H <sub>5</sub> OCH <sub>3</sub>
10	22.7	"	15	14.3	"	-36.5†	11.8	" +1.1
0	42.5	"	5	28.5	"	-30	16	1.1
-5	48.5	"	1†	31.8	" +1.1	-10	28.3	"
-9†	52.7	" +1.1	15	35.4	1.1	+10	43	"
0	59	1.1	35	41.6	"	20	52.8	"
10	67.3	"	55	55.2	"	25‡	63.6	" +2.1
19*	79.1	"	60.5*	65.4	"	35	70	2.1
25	81.5	SbCl <sub>3</sub>	45	79.3	"	41.5*	80.9	"
45	87.4	"	32†	84	1.1 + SbCl <sub>3</sub>	40†	84.5	" + SbCl <sub>3</sub>
65	95.3	"	50	89.3	SbCl <sub>3</sub>	60	92	SbCl <sub>3</sub>
73	100	"	70	98.2	"	70	98	"

SbCl <sub>3</sub> + Aniline.			SbCl <sub>3</sub> + Benzaldehyde.			SbCl <sub>3</sub> + Benzophenone.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-7.1†	1	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> + 1.4	10	43.5	1.1	48*	0	C <sub>6</sub> H <sub>5</sub> COC <sub>6</sub> H <sub>5</sub>
+20	7	1.4	20	47.5	"	40	16.3	"
60	18.7	"	30	52.4	"	35†	21.6	" +1.1
77‡	20.6	1.4 + 1.3	40	60.2	"	45	26.2	1.1
88*	44.8	1.3	43.5*	68.1	"	55	31.4	"
87†	46.3	1.3 + 1.2	40	74.2	"	65	37.5	"
94.5†	54.9	1.2	30	80.6	"	76*	55.4	"
89.5†	61.7	1.2 + 1.1	25†	83	1.1 + SbCl <sub>3</sub>	65	71.6	"
100.5*	71	1.1	35	85	SbCl <sub>3</sub>	45	80.6	"
70	82.2	"	45	87.5	"	39†	82.7	" + SbCl <sub>3</sub>
31†	88	1.1 + SbCl <sub>3</sub>	65	95.2	"	50	87	SbCl <sub>3</sub>
60	94.9	SbCl <sub>3</sub>	73	100	"	70	97.7	"

1.1 = compound of equimolecular amounts of the two constituents in each case.

2.1 = compound of 2 molecules of SbCl<sub>3</sub> with 1 molecule of the other constituent.1.2, 1.3 and 1.4 = compounds of 1 molecule of SbCl<sub>3</sub> with 2, 3 and 4 molecules of aniline.

SbCl <sub>3</sub> + Benzoic Acid.		SbCl <sub>3</sub> + Benzoyl Chloride.		SbCl <sub>3</sub> + Benzene Sulphonic Acid.		SbCl <sub>3</sub> + Tetrahydrobenzene.	
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.
20	0	-5	17.8	52.5*	0	-25	19.1
10	23	-15	36.8	45	18	-15	24
00	38.8	-23†	45	25	43.7	-5	30
90	50	-5	50.7	5	56.1	+5	37.1
80	59	+15	58.2	-5†	60.8	15	45.1
70	66	25	62.9	+5	49.8	25	54.3
60	71.6	35	68.4	25	56.7	35	64.5
46†	78	45	74.9	45	69.2	45	74
60	89.2	55	82.4	65	90.2	55	83.6
70	97.5	70	96.5	73	100	65	92.8

Molecular compounds are not formed in the above systems. The diagram in each case consists of two arms meeting at the eutectic.

\* m. pt.

† Eutec.

‡ tr. pt.



RECIPROCAL SOLUBILITIES OF ANTIMONY TRICHLORIDE AND VARIOUS OTHER  
COMPOUNDS, DETERMINED BY THE "SYNTHETIC METHOD."  
(Menschutkin, 1910-'11.)

SbCl <sub>3</sub> + Benzene.			SbCl <sub>3</sub> + Brombenzene.			SbCl <sub>3</sub> + Chlorbenz.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	
4 *	7.3	C <sub>6</sub> H <sub>6</sub>	-31 †	0	C <sub>6</sub> H <sub>5</sub> Br	-45.2 †	0	
1	19.4	" + 2.1	-32.5 *	4.8	" + 1.1	-47 *	4.3	
10	24.6	2.1	-30	6.8	1.1	-40	7	
20	30.5	"	-20	14.8	"	-30	11.1	
40	44.1	"	-10	23.9	"	-15	20.5	
60	60.6	"	0	34.3	"	-5	32.5	
75	76.8	"	+ 3 †	40.3	1.1 + SbCl <sub>3</sub>	0 †	44.2	
79 †	85.3	"	20	52	SbCl <sub>3</sub>	20	56	
70	93.5	"	40	68	"	40	72.1	
62 *	96	2.1 + SbCl <sub>3</sub>	60	85.8	"	60	88.2	
67.5	97.9	SbCl <sub>3</sub>	73	100	"	73	100	

SbCl <sub>3</sub> + Fluorbenzene.			SbCl <sub>3</sub> + Iodobenzene.			SbCl <sub>3</sub> + Nitrobenz.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	
-39.2 †	0	C <sub>6</sub> H <sub>5</sub> F	-28.6 †	0	C <sub>6</sub> H <sub>5</sub> I	6 †	0	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>
-40.5 *	2.4	" + 1.1	-35	12.8	"	-2	20.4	†
-25	11	1.1	-45 *	29.8	" + 1.1	-10	32	†
-15	17.3	"	-34.5	11.7	1.1, unstable	-16.5 *	38	†
-10	21.4	"	-15	26.4	"	-10.5	44	
-5	26.4	"	-3	49.1	"	-7.5	50	
0	34.1	"	-35	32.5	1.1 + SbCl <sub>3</sub>	-6 †	64.8	
+ 5.5 †	45.8	1.1 + SbCl <sub>3</sub>	-15	38.9	SbCl <sub>3</sub>	-6.5 *	67.5	1.
15	53.6	SbCl <sub>3</sub>	+ 5	46.4	"	+ 5	69.6	
25	61.6	"	25	56	"	35	78.7	
45	77.7	"	45	69.6	"	55	87.4	
65	93.8	"	65	88.8	"	70	96.6	

SbCl <sub>3</sub> + Ethylbenzene.			SbCl <sub>3</sub> + Benzonitrile.			SbCl <sub>3</sub> + Isoamylb.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	
-93 †	0	C <sub>6</sub> H <sub>5</sub> .C <sub>2</sub> H <sub>5</sub>	-13.2 †	0	C <sub>6</sub> H <sub>5</sub> CN	-80	4	
-93.5 *	0.3	" + 1.1	-16	10.2	"	-60	11.7	
-70	0.6	1.1	-19 *	17.2	" + 1.1	-40	25.4	
-50	1.1	"	-10	21.9	1.1	-33 †	32.7	1
-30	2.5	"	0	28.5	"	-25	38.7	
-10	7	"	10	38.7	"	-15	47.2	
+ 10	18.8	"	15	47.4	"	-5 †	56.8	2.
30	44.4	"	20	62.6	"	0	57.4	
39 †	68.1	"	21.5 †	68.7	"	20	63.3	
35 *	77.4	1.1 + 2.1	20	72.4	"	40	72.6	
37 †	81.1	2.1	15 *	78.9	"	60	87.1	
36.8 *	81.8	2.1 + SbCl <sub>3</sub>	25	81.6	"	70	97.3	
50	87.2	SbCl <sub>3</sub>	45	87.6	"	...	...	
70	98	"	65	95.6	"	-25	44.4	unsta
...	...	...	73	100	"	-21 †	54.9	" 1
33	80.4	1.1 + SbCl <sub>3</sub> (unstable)				-10	56	" 5

\* Eutec.

† m. pt.

† tr. pt.

1.1 = compound of equimolecular amounts of the two constituents in each  
2.1 = compound of 2 molecules of SbCl<sub>3</sub> with 1 molecule of the other  
constituent.



RECIPROCAL SOLUBILITIES OF ANTIMONY TRICHLORIDE AND VARIOUS ORGANIC COMPOUNDS, DETERMINED BY THE "SYNTHETIC METHOD."

(Menschutkin, 1910-11.)

SbCl <sub>3</sub> + m Dinitrobenzene.					SbCl <sub>3</sub> + Propylbenzene.				
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	
90°	0	m C <sub>6</sub> H <sub>4</sub> (NO <sub>2</sub> ) <sub>2</sub>	20	72.8	unstable	1.1	-70	0.6	2.1
80	18.6	"	15	76.2	"	"	-30	10.1	"
70	31.3	"	10	78.6	"	"	-10	26.6	"
60	40.7	"	5	80.8	"	"	0	40.4	"
50	48	"	0	82.7	"	"	7	57.5	"
40	53.6	"	-10	64.9	"	SbCl <sub>3</sub>	8.5 †	68.2	" + SbCl <sub>3</sub>
30	58	"	+10	69	"	"	20	71.4	SbCl <sub>3</sub>
20	61.5	unstable	20	71.6	"	"	40	78.5	"
10	64.5	"	30	74.8	"	"	65	92.5	"
1†	66.8	" + SbCl <sub>3</sub>	40	78.7	"	"	...	...	...
-11	68.8	"	50	83.5	"	-70	1.5	1.1	unstable
+27.5	52.5	1.1	60	89	"	-30	16	"	"
28.5°	58.2	"	70	96.4	"	-5	48.2	"	"
27.5	63	"	73	100	"	+1.5*	65.3	"	"
25	67.5	"				1†	66.3	" + SbCl <sub>3</sub>	"
						10	68.6	SbCl <sub>3</sub>	"

SbCl <sub>3</sub> + p Dibrombenzene.			SbCl <sub>3</sub> + p Dichlorbenzene.			SbCl <sub>3</sub> + Cyclohexane.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.		t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.		t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	
88°	0		54.5*	0		6.4*	0.0	
85	5.7		50	14		6†	0.2	
80	15.4		45	30		20	1.2	
70	35		40	48		40	4.2	
60	52.8		39.5†	50.5		60	9.7	
55	59		45	59.5		Two liquid layers formed		
49.5†	64		50	67.8		70	13.7	97
65	71.8		55	75.7		80	19.5	96.1
60	79.3		60	83		100	32.3	92.7
70	95		70	96.2		120	57.1	83.2
						124	58.9	76.7
						125.5§	68	

SbCl <sub>3</sub> + p Cymene.			SbCl <sub>3</sub> + Pseudocymene.			SbCl <sub>3</sub> + Diphenyl.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-75°	0	p C <sub>6</sub> H <sub>4</sub> CH <sub>2</sub> C <sub>6</sub> H <sub>7</sub>	-57.4*	0	C <sub>6</sub> H <sub>5</sub> (CH <sub>3</sub> ) <sub>2</sub> 1, 2, 4	70.5*	0	C <sub>6</sub> H <sub>5</sub> ·C <sub>6</sub> H <sub>5</sub>
-76.5†	2	" + 1.1	-60†	18.6	" + 1.1	65	14	"
-50	7	1.1	-45	23.6	1.1	55	33.4	"
-30	15	"	-25	33.3	"	50†	40	" + 2.1
-10	30	"	-10	45	"	55	45.2	2.1
-3.5†	41	1.1 + 2.1	-5†	50.7	" + 2.1	60	51.4	"
10	46.1	2.1	+15	55.8	2.1	70	70.7	"
30	60	"	35	62.2	"	71*	74.6	"
40†	76.4	2.1 + SbCl <sub>3</sub>	50	69.7	"	65	85.5	"
50	81.2	"	56*	79.2	"	57†	88.9	2.1 + SbCl <sub>3</sub>
60	87	"	51†	87.5	2.1 + SbCl <sub>3</sub>	65	93.1	SbCl <sub>3</sub>
70	95.6	"	65	93.9	SbCl <sub>3</sub>	70	97	"

\* m. pt.

† Eutec.

‡ tr. pt.

§ crit. t.

1.1 = compound of equimolecular amounts of the two constituents in each case.  
2.1 = compound of 2 molecules of SbCl<sub>3</sub> with 1 molecule of the other constituent.



RECIPROCAL SOLUBILITIES OF ANTIMONY TRICHLORIDE AND VARIOUS  
 COMPOUNDS, DETERMINED BY THE "SYNTHETIC METHOD."

(Menschutkin, 1910-11.)

SbCl <sub>3</sub> + Mesitylene.			SbCl <sub>3</sub> + Diphenyl Methane.			SbCl <sub>3</sub> + Triphenyl Methane.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-54.4 *	0	C <sub>6</sub> H <sub>3</sub> (CH <sub>3</sub> ) <sub>3</sub> 1, 3, 5	26 *	0	CH <sub>2</sub> (C <sub>6</sub> H <sub>5</sub> ) <sub>2</sub>	92 *	0	Cl
-55.6	1.5	" +1.1	22.5 †	7.9	" +2.1	85	11.8	
-40	3	1.1	40	15.1	2.1	80	19.3	
-20	7	"	60	26	"	70	32	
0	14.2	"	70	33	"	60	42.4	
10	20.3	"	80	41.6	"	50	49.6	
30	39.3	"	90	52.7	"	49 †	50	
38 †	51.4	" +2.1	95	59.8	"	45	62.8	
65	65.4	2.1	100 *	72.9	"	40	68.3	
75.5 *	79.2	"	95	82.2	"	35 †	72	1.
70	87	"	90	86.7	"	45	76.6	
58.5	92.4	" +SbCl <sub>3</sub>	80	91.5	"	55	82.4	
63	94	SbCl <sub>3</sub>	67 †	95.7	2.1 +SbCl <sub>3</sub>	65	90.6	
70	98	"	70	97	SbCl <sub>3</sub>	70	96.1	

SbCl <sub>3</sub> + Naphthalene.			SbCl <sub>3</sub> + α Chlor-naphthalene.			SbCl <sub>3</sub> + β Chlor-naphthalene.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
79.4 *	0	C <sub>10</sub> H <sub>8</sub>	-17 *	0	α C <sub>10</sub> H <sub>7</sub> Cl	56	0	β
75	15.2	"	-21 †	8.1	" +2.1	50	16.6	
65	35	"	0	14.4	2.1	45	27.2	
59 †	42.8	" +2.1	10	18.7	"	40	35.4	
65	48.4	2.1	20	24.6	"	30	47.3	
75	58.8	"	30	33.5	"	25 †	52.3	
80	65	"	40	47.7	"	29.5 *	58.2	
86 *	78	"	45	61.5	"	28 †	64	1.
80	88.7	"	46 *	73.6	"	35	68.3	
70	93	"	45.5 †	75	2.1 +SbCl <sub>3</sub>	45	75.3	
65 †	94	2.1 +SbCl <sub>3</sub>	55	82.2	SbCl <sub>3</sub>	60	87.5	
70	97.2	SbCl <sub>3</sub>	70	96.5	"	73	100	

SbCl <sub>3</sub> + α Bromnaphthalene.			SbCl <sub>3</sub> + α Nitronaphthalene.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
3 *	0	α C <sub>10</sub> H <sub>7</sub> Br	57 *	0	α C <sub>10</sub> H <sub>7</sub> N
-1 †	8.3	" +1.1	50	13.6	
10	12.8	1.1	40	27.3	
25	24	"	30 †	35.8	
33	38.5	"	35	43.2	
34.5 *	52.4	"	37.5	49.3	
33	62.1	"	39 *	56.7	
31.5 †	64.7	1.1 +SbCl <sub>3</sub>	37.5	64.9	
40	69.7	SbCl <sub>3</sub>	34.5 †	72.8	1.1-S
50	76.2	"	45	78	S
60	84.5	"	60	87.4	
70	94.8	"	70	96.6	

\* m pt.

† tr. pt.

‡ Eutec.

1.1 = compound of equimolecular amounts of the two constituents case.

2.1 = compound of 2 molecules of SbCl<sub>3</sub> with 1 molecule of the other constituent.



RECIPROCAL SOLUBILITIES OF ANTIMONY TRICHLORIDE AND VARIOUS ORGANIC COMPOUNDS, DETERMINED BY THE "SYNTHETIC METHOD."

(Menschutkin, 1910-12.)

SbCl <sub>3</sub> + Phenol.			SbCl <sub>3</sub> + Phenetol.			SbCl <sub>3</sub> + Toluene.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
41*	0	C <sub>6</sub> H <sub>5</sub> OH	-28.6*	0	C <sub>6</sub> H <sub>5</sub> OC <sub>2</sub> H <sub>5</sub>	-93*	0	C <sub>6</sub> H <sub>5</sub> .CH <sub>3</sub>
35	16.2	"	-29†	1.4	" +1.1	-94†	1.1	" +1.1
30	25.6	"	-20	4.5	1.1	-70	3.1	1.1
20	38.7	"	-10	8.1	"	-30	15.8	"
10	48	"	+10	18.2	"	0	41.5	"
5†	52	" +2.1	20	27.4	"	11‡	57.8	" +2.2
15	58.6	2.1	30	39.4	"	20	62.8	2.1
30	70.6	"	40	58	"	40	78	"
37*	83	"	42.2*	65	"	42.5*	83.1	"
36.5†	83.7	2.1 + SbCl <sub>3</sub>	35†	77.8	"	40†	85.8	2.1 + SbCl <sub>3</sub>
55	90.6	SbCl <sub>3</sub>	50	86.8	"	50	89	SbCl <sub>3</sub>
70	98.2	"	70	97.1	"	70	97.8	"

SbCl <sub>3</sub> + o Chlortoluene.			SbCl <sub>3</sub> + m Chlortoluene.			SbCl <sub>3</sub> + p Chlortoluene.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-36.2*	0	o ClC <sub>6</sub> H <sub>4</sub> CH <sub>3</sub>	-47.8*	0	m ClC <sub>6</sub> H <sub>4</sub> CH <sub>3</sub>	6.2*	0	p ClC <sub>6</sub> H <sub>4</sub> CH <sub>3</sub>
-37.5†	6.9	" +1.1	-49†	6.9	" +1.1	3	12.7	"
-20	18.3	1.1	-40	12.3	1.1	0	23.5	"
-10	29.2	"	-30	20.1	"	-3	32.2	"
-5	37.1	"	-20	31	"	-7.5†	43.8	" + SbCl <sub>3</sub>
-0.5‡	47.9	1.1 + SbCl <sub>3</sub>	-14‡	40	1.1 + SbCl <sub>3</sub>	0	47.2	SbCl <sub>3</sub>
+10	53.1	SbCl <sub>3</sub>	0	46.1	SbCl <sub>3</sub>	10	52.2	"
20	58.2	"	10	51.6	"	30	64.8	"
30	64.6	"	20	57.4	"	40	72.3	"
40	71.8	"	40	72.8	"	50	80.2	"
60	88.4	"	60	89.1	"	60	88.8	"
73	100	"	73	100	"	70	97.4	"

SbCl <sub>3</sub> + o Nitrotoluene.			SbCl <sub>3</sub> + m Nitrotoluene.			SbCl <sub>3</sub> + p Nitrotoluene.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-8.5*	0	o NO <sub>2</sub> C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub>	16*	0	m NO <sub>2</sub> C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub>	52.5*	0	p NO <sub>2</sub> C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub>
-13.5	11.3	"	10	15	"	45	18.5	"
-18.5†	18.5	" +1.1	0	30.7	"	35	33.6	"
-10	21.3	1.1	-10	39.2	"	30	38.8	"
+10	31.1	"	-20	42.8	"	20	46	"
20	39	"	crystallization not obtained here			7.5†	52	" +1.1
30	50	"	0	67.2	SbCl <sub>3</sub>	7.5*	62.3	1.1
34.5*	62.3	"	20	72.5	"	5	66.1	"
33	68	"	30	76.3	"	3†	68.5	1.1 + SbCl <sub>3</sub>
27.5†	74.6	" + SbCl <sub>3</sub>	40	80.8	"	10	70	SbCl <sub>3</sub>
40	79.1	SbCl <sub>3</sub>	50	86	"	30	75.5	"
50	84.5	"	60	91.6	"	50	85	"
70	97.5	"	73	100	"	70	97.5	"

\* m. pt.

† Eutec.

‡ tr. pt.

1.1 = compound of equimolecular amounts of the two constituents in each case.

2.1 = compound of 2 molecules of SbCl<sub>3</sub> with 1 molecule of the other constituent.



## RECIPROCAL SOLUBILITIES OF ANTIMONY TRICHLORIDE AND VARIOUS ORGANIC COMPOUNDS, DETERMINED BY THE "SYNTHETIC METHOD."

(Menschutkin, 1910.)

SbCl <sub>3</sub> + <i>o</i> Xylene.			SbCl <sub>3</sub> + <i>m</i> Xylene.			SbCl <sub>3</sub> + <i>p</i> Xylene.		
t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. SbCl <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-29°	0	<i>o</i> C <sub>6</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>2</sub>	-57°	0	<i>m</i> C <sub>6</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>2</sub>	14°	0	<i>p</i> C <sub>6</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>2</sub>
-35†	14	" +1.1	-60.5†	7.5	" +1.1	11.7†	11.7	" +1.1
-30	17.5	1.1	-45	15.8	1.1	20	17.5	1.1
-20	24.8	"	-25	29	"	40	37.3	"
-10	33.4	"	-5	46.2	"	50	52.3	"
0	43.4	"	-2‡	49.8	" +2.1	55‡	62.7	" +2.1
10	55	"	5	53.1	2.1	60	66.1	2.1
19.5*	68.1	"	15	58.7	"	70*	81	"
25	71.3	2.1	25	65.7	"	65	88.1	"
30	75.7	"	33	73.8	"	58†	92	" +SbCl <sub>3</sub>
33.5*	81	"	38*	81	"	69	97.2	SbCl <sub>3</sub>
31.5†	82.5	2.1 +SbCl <sub>3</sub>	36.5†	83.7	2.1 +SbCl <sub>3</sub>	...	...	...
50	88	SbCl <sub>3</sub>	50	87.7	SbCl <sub>3</sub>	10	20.7	<i>p</i> C <sub>6</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>2</sub> unstable
60	92.4	"	60	91.5	"	7†	32.8	" +2.1
71	98.5	"	70	97.2	"	35	50.3	2.1
						55	62.7	"

\* m. pt.

† Eutec.

‡ tr. pt.

1.1 = compound of equimolecular amounts of the two constituents in each case.

2.1 = compound of 2 molecules of SbCl<sub>3</sub> with 1 molecule of the other constituent.

## DISTRIBUTION OF ANTIMONY TRI AND PENTACHLORIDES BETWEEN AQUEOUS HCl AND ETHER AT ROOM TEMPERATURE

(Mylius, 1911)

When 1 gm. of antimony as SbCl<sub>3</sub> or as SbCl<sub>5</sub> is dissolved in 100 cc. of aq. HCl of the following strengths and the solution shaken with 100 cc. of ether, an amount of metal, depending upon the concentration of the aq. acid solution, enters the ethereal layer.

With 1% SbCl <sub>3</sub> Solution.	
Per cent Conc. of HCl.	Per cent of Total Sb in Ether Layer.
20	6
15	13
10	22
5	8
1	0.3

With 1% SbCl <sub>5</sub> Solution.	
Per cent Conc. of HCl.	Per cent of Total Sb in Ether Layer.
20	81
15	22
10	6
5	2.5
1	trace

Solubility data determined by the freezing-point method (see footnote, p. 1) are given for mixtures of antimony trichloride and each of the following compounds: azobenzene, benzil, *s* diphenylethane, and stilbene (Van Stone, 1914); benzene, naphthalene, diphenylmethane and triphenylmethane (Kurnakov, Krotkov and Oksman, 1915); SbBr<sub>3</sub>, SbI<sub>3</sub>, and SbBr<sub>3</sub> + SbI<sub>3</sub> (Bernadis, 1912); SbCl<sub>5</sub> (Aten, 1909).

ANTIMONY PentaCHLORIDE SbCl<sub>5</sub>.

Data for the freezing-points of mixtures of antimony pentachloride and antimony pentafluoride are given by Ruff (1909).



**ANTIMONY TRIFLUORIDE  $\text{SbF}_3$ .****SOLUBILITY IN WATER.**  
(Rosenheim and Grünbaum, 1909.)

°.	Gms. $\text{SbF}_3$ per 100 Gms.	
	Water.	Sat. Solution.
0	384.7	79.4
20	444.7	81.6
22.5	452.8	81.9
25	492.4	83.1
30	563.6	84.9

**SOLUBILITY IN AQUEOUS SOLUTIONS OF SALTS AND OF HYDROFLUORIC ACID AT 0°.**

Normality of Aq. Salt Solution.	Gms. $\text{SbF}_3$ per 100 Gms. $\text{H}_2\text{O}$ present in Aq. Solutions of:							
	KCl.	KBr.	$\text{KNO}_3$ .	$\text{K}_2\text{SO}_4$ .	$\text{K}_2\text{C}_2\text{O}_4$ .	$(\text{NH}_4)_2\text{C}_2\text{O}_4$ .	$\text{K}_2\text{C}_4\text{H}_4\text{O}_6$ .	HF.
1	461.8	448.7	458.2	419.9	465.7	...	461.4	432.5
0.5	448.3	450	451.9	408.5	481.2	431.9	430.5	404
0.25	431.9	455.6	418.3	406.6	451.3	442.3	430.8	...
0.125	407.3	417.2	401.4	...	405.2	433.3	435.2	*479.4

\* (2 % HF.)

Celluloid flasks were used and all measuring apparatus provided with HF resistant coating. The  $\text{SbF}_3$  was prepared in the form of rhombic transparent crystals from  $\text{Sb}_2\text{O}_3$  and HF.

**ANTIMONY TRIIODIDE  $\text{SbI}_3$ .****SOLUBILITY IN METHYLENE IODIDE AT 12°.**

(Retgers, 1893.)

100 parts  $\text{CH}_2\text{I}_2$  dissolve 11.3 parts  $\text{SbI}_3$ . Sp. Gr. of solution = 3.453.**SOLUBILITY DATA DETERMINED BY THE FREEZING-POINT METHOD ARE GIVEN FOR MIXTURES OF:**

Antimony triiodide and arsenic triiodide.

(Quercigh, 1912; Jaeger and Dornbosch, 1912; Vasilev, 1912.)

“ “ “ phosphorus triiodide. (Jaeger and Dornbosch, 1912.)

“ “ “ iodine. (Quercigh, 1912.)

**ANTIMONY TRIOXIDE  $\text{Sb}_2\text{O}_3$ .**

Freezing-point data are given for mixtures of antimony trioxide and antimony trisulfide. (Quercigh, 1912.)

**ANTIMONY TRIPHENYL  $\text{Sb}(\text{C}_6\text{H}_5)_3$ .**

Freezing-point data are given for mixtures of antimony triphenyl and mercury diphenyl and for antimony triphenyl and tin tetraphenyl. (Cambi, 1912.)

**ANTIMONY SELENIDES  $\text{SbSe}$ ,  $\text{Sb}_2\text{Se}_3$ .**

Freezing-point data for  $\text{SbSe} + \text{Ag}_2\text{Se}$  and  $\text{Sb}_2\text{Se}_3 + \text{Ag}_2\text{Se}$ . (Pélabon, 1908.)

**ANTIMONY TRISULPHIDE  $\text{Sb}_2\text{S}_3$ .**

1000 cc. water dissolve 0.00175 gm.  $\text{Sb}_2\text{S}_3$  at 18°. (Weigel, 1907.)

**SOLUBILITY DATA DETERMINED BY THE FREEZING-POINT METHOD ARE GIVEN FOR MIXTURES OF:**

Antimony trisulphide and cuprous sulfide. (Parravano and Cesaris, 1912.)

“ “ “ stannous sulfide. “ “

“ “ “ lead sulfide. (Jaeger and Van Klooster, 1912; Pélabon, 1913.)

“ “ “ silver sulfide. (Jaeger and Van Klooster, 1912.)



# ANTIMONY TARTRATE

96

## ANTIMONY Potassium TARTRATE $C_2H_2(OH)_2(COOK)(COOSbO) \cdot \frac{1}{2}H_2O$ .

100 gms. water dissolve	5.9 gms. salt at room temp.	(Squire and Caines, 1905.)
" " " "	6.9 " " " 25°.	(S and S, 1903.)
" " " "	8 " " " 21°.	(Aschan, 1913.)
" 95% HCOOH dissolve	82.7 gms. salt at 20.8°.	(Aschan, 1913.)
" glycerol dissolve	5.5 gms. salt at 15.5°.	

### SOLUBILITY OF ANTIMONY POTASSIUM TARTRATE IN AQ. ALCOHOL SOLUTIONS AT 25°. (Seidell, 1910.)

Wt. Per cent $C_2H_5OH$ in Solvent.	$d_m$ of Sat. Sol.	Gms. $C_2H_5O_4$ $KSbO \cdot \frac{1}{2}H_2O$ per 100 Gms. Sat. Sol.	Wt. Per cent $C_2H_5OH$ in Solvent.	$d_m$ of Sat. Sol.	Gms. $C_2H_5O_4$ $KSbO \cdot \frac{1}{2}H_2O$ per 100 Gms. Sat. Sol.
0	1.052	7.85	40	0.935	0.38
5	1.025	5.50	50	0.913	0.23
10	1.007	3.92	60	0.890	0.12
20	0.980	1.92	70	0.866	0.06
30	0.958	0.84	100	0.788	trace

## ANTIPYRINE $C_{11}H_{12}N_2O$ .

100 gms. water	dissolve	80 gms. $C_{11}H_{12}N_2O$ at 15°.	(Greenish and Smith, '03.)
" "	"	100 " " 25°.	(U. S. P.)
" alcohol	"	100 " " "	"
" 90% alcohol	"	75.2 " " "	"
" chloroform	"	100 " " "	"
" ether	"	1.3 " " "	(Enell, 1899.)
" pyridine	"	38.0 " " at 20-25°.	(Dehn, 1917.)
" 50% aq. pyridine	"	79.61 " " "	"

### THE SOLIDIFICATION POINTS OF MIXTURES OF ANTIPYRINE AND CHLORAL HYDRATE. (Tsakalatos, 1913.)

t° of Solidification.	Gms. $C_{11}H_{12}N_2O$ per 100 Gms. Mixture.	Solid Phase.	t° of Solidification.	Gms. $C_{11}H_{12}N_2O$ per 100 Gms. Mixture.	Solid Phase.
108.9	100	$C_{11}H_{12}N_2O$	60	40.9	1.2
90	86.1	"	61.8 m. pt.	36.7	"
70	73	"	57	30.1	"
50.5 Eutec.	64.2	" + 1.1	50	26.1	"
60	56.8	1.1	40	20.2	"
62.3 m. pt.	53.2	"	33.8 Eutec.	16.5	1.2 + $CCl_3COH \cdot H_2O$
60	50.3	"	40	6	$CCl_3COH \cdot H_2O$
56 Eutec.	47.2	" + 1.2	51.6	0	"

1.1 =  $C_{11}H_{12}N_2O \cdot CCl_3COH \cdot H_2O$  (Hypnal).

1.2 =  $C_{11}H_{12}N_2O \cdot 2(CCl_3COH \cdot H_2O)$  (Bihypnal).

### THE SOLIDIFICATION POINTS (Solubility, see footnote, p. 1), OF MIXTURES OF ANTIPYRINE AND SALOL. (Bellucci, 1912, 1913.)

Initial t° of Solidification.	Gms. $C_{11}H_{12}N_2O$ per 100 Gms. Mixture.	Initial t° of Solidification.	Gms. $C_{11}H_{12}N_2O$ per 100 Gms. Mixture.
112.6	100	65	40
104.5	90	53	30
98	80	30 Eutec.	17
91	70	34	20
83	60	35	10
75	50	42	0



## 97 APOMORPHINE HYDROCHLORIDE

### APOMORPHINE HYDROCHLORIDE $C_{17}H_{17}NO_2 \cdot HCl$ .

100 gms. water dissolve 1.7 gms. salt at 15° and 2 gms. at 25°.

100 gms. 90% alcohol dissolve 2 gms. salt at 25°.

(Dott, 1906; Squires and Caines, 1905.)

### ARACHIDIC ACID $C_{20}H_{40}O_2$ .

SOLUBILITY DATA DETERMINED BY THE FREEZING-POINT METHOD ARE  
GIVEN BY MEYER, BROD AND SOYKA (1913), FOR MIXTURES OF:

Arachidic and Stearic Acids.  
" " Palmitic Acids.  
" " Lignoceric Acids.

### ARBUTIN $C_{12}H_{16}O_7 \cdot \frac{1}{2}H_2O$ .

100 gms. trichlorethylene dissolve 0.011 gm. arbutin at 15°.

(Wester and Bruins, 1914.)

### ARGON, A.

#### SOLUBILITY IN WATER.

(Estreicher — Z. physik. Chem. 31, 184, '99.)

t°.	Cor. Bar. Pressure.	Vol. H <sub>2</sub> O.	Vol. Absorbed Argon.	Absorption Coefficients.*		Solubility. g.
				a.	l.	
0	...	...	...	...	0.0578	0.0102
2	764.9	77.40	4.34	0.0561	0.0561	0.0099
5	765.0	77.39	3.92	0.0507	0.0508	0.0090
10	765.3	77.41	3.49	0.0450	0.0453	0.0079
15	762.4	77.46	3.13	0.0404	0.0410	0.0072
20	757.6	77.53	2.86	0.0369	0.0379	0.0066
25	766.7	77.62	2.64	0.0339	0.0347	0.0060
30	760.6	77.73	2.43	0.0312	0.0326	0.0056
35	757.1	77.86	2.24	0.0288	0.0305	0.0052
40	758.3	77.99	2.07	0.0265	0.0286	0.0048
45	756.4	78.15	1.92	0.0246	0.0273	0.0045
50	747.6	78.31	1.73	0.0221	0.0257	0.0041

a = under barometric pressure minus tension of H<sub>2</sub>O vapor.

l = under 760 mm. pressure.

q = grams argon per 100 g. H<sub>2</sub>O when total pressure is equal to 760 mm.

\* See Acetylene, page 16.

#### SOLUBILITY OF ARGON AND WATER.

(von Antropoff, 1909-10.)

t°.	Coef. of Absorption.
0	0.0561
10	0.0438
20	0.0379
30	0.0348
40	0.0338
50	0.0343

The coef. of absorption adopted for these results is that of Bunsen as modified by Kuenen. The modification consists in substituting unit of mass in place of unit of volume of water in the formula.

Data for the solubility of argon in water and in sea water, together with a critical discussion of the literature, are given by Coste (1917).

Data for the solubility and diffusion of argon in solid and liquid metals are given by Sieverts and Bergner (1912).



**ARSENIC As.**

Data for the fusion-points of mixtures of arsenic and iodine are given Jaeger and Doornbosch (1912).

**MetaARSENIC ACID AsO<sub>2</sub>H.****DISTRIBUTION AT 25° BETWEEN:**

(Auerbach, 1903.)

H <sub>2</sub> O and Amyl Alcohol.		Sat. Aq. H <sub>3</sub> BO <sub>3</sub> Solution and Amyl Alcohol.	
Gms. AsO <sub>2</sub> H per 1000 cc.		Gms. AsO <sub>2</sub> H per 1000 cc.	
Aq. Layer.	Alcoholic Layer.	Aq. Layer.	Alcoholic Layer.
4.82	0.90	9.28	1.75
9.63	1.75	18.74	3.47
18.44	3.50		

**ARSENIC TRIBROMIDE and TRIIODIDE AsBr<sub>3</sub> and AsI<sub>3</sub>.**

100 gms. H<sub>2</sub>O dissolve about 6 gms. AsI<sub>3</sub> at 25°.

(U. S. N)

100 gms. carbon disulfide dissolved about 5.2 gms. AsI<sub>3</sub>.

(Squires

100 gms. methylene iodide, CH<sub>2</sub>I<sub>2</sub>, dissolve 17.4 gms. AsI<sub>3</sub> at 12°, *d* of solution = 3.449.

(Retgers, 1891

**SOLUBILITY DATA DETERMINED BY THE FREEZING-POINT METHOD ARE GIVEN FOR MIXTURES OF:**

Arsenic tribromide and naphthalene.

(Pushin and Kriger, 1914

" " phosphorus triiodide.

(Jaeger and Doornbosch, 1912

" triiodide and iodine.

(Quercigh, 1912

**ARSENIC TRICHLORIDE AsCl<sub>3</sub>.**

When 1.0 gm. of arsenic as the trichloride is dissolved in 100 cc. of aq. HCl and the solution shaken with 100 cc. of ether the following percentages of the metal enter the ethereal layer; with 20% HCl, 68%; 15% HCl, 37%; 10% HCl, 7%; 5% HCl, 0.7% and with 1% HCl, 0.2% of the arsenic. (Mylus, 1911

**ARSENIC TRIOXIDE As<sub>2</sub>O<sub>3</sub>.****SOLUBILITY OF THE:****Crystallized Modification.****In Water.**

t°.	Gms. As <sub>2</sub> O <sub>3</sub> per 100 cc. Sat. Solution.
2	1.201
15	1.657
25	2.038
39.8	2.930
b. pt.	6. +

(Bruner and St. Tolloczko — Z. anorg. Chem. 37, 456, '03; Chodounsky — Listy. Chem. 13, 114, '88.)

**Amorphous Modification.****In Water.**

t°.	Gms. As <sub>2</sub> O <sub>3</sub> per 100 cc. H <sub>2</sub> O.
ord. temp.	3.7
b. pt.	11.86
<b>In Alcohol, Ether and CS<sub>2</sub>.</b>	
G. As <sub>2</sub> O <sub>3</sub> per 100 g. Solvent	
Alcohol	0.446
Ether	0.454
CS <sub>2</sub>	0.001

(Winkler — J. pr. Chem. [2] 31, 347, '85.)

**SOLUBILITY OF ARSENIC TRIOXIDE IN AQUEOUS SOLUTIONS OF AMMONIA / 30° (INTERPOLATED FROM ORIGINAL RESULTS).**

(Schiemmakers and deBaar, 1915.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
NH <sub>3</sub> .	As <sub>2</sub> O <sub>3</sub> .		NH <sub>3</sub> .	As <sub>2</sub> O <sub>3</sub> .	
0	2.3	As <sub>2</sub> O <sub>3</sub>	4	7.6	NH <sub>4</sub> AsO
1	8.3	"	5	6.2	"
2	14.9	"	7	4.6	"
2.8	20.5	As <sub>2</sub> O <sub>3</sub> + NH <sub>4</sub> AsO <sub>2</sub>	10	3.1	"
3	13	NH <sub>4</sub> AsO <sub>4</sub>	13	2.4	"
3.5	9.1	"	14.3	2.2	"



SOLUBILITY OF ARSENIC TRIOXIDE IN WATER AND IN AQUEOUS SOLUTION OF HYDROCHLORIC ACID AT 15° (Interpolated from the original).

(Wood, 1908.)

Mols. HCl per Liter.	Gms. $As_2O_3$ per 100 cc. Solution.	Mols. HCl per Liter.	Gms. $As_2O_3$ per 100 cc. Solution.
0	1.495	6	3.8
0.46	1.5	7	7.5
2	1.2	8	12.5
4	1.3	9	17.7

SOLUBILITY OF ARSENIC TRIOXIDE IN AQUEOUS SALT SOLUTIONS.

(Schreinemakers and deBaar, 1917.)

In Aq. Ammonium Bromide at 30°.

Gms. per 100	Gms. Sat. Sol.	Solid Phase.
$As_2O_3$	$NH_4Br$	
2.26	0	$As_2O_3$
2.25	0.339	" + $As_2O_3 \cdot NH_4Br$
0.679	4.37	$As_2O_3 \cdot NH_4Br$
0.518	7.18	"
0.386	13.31	"
0.303	20.14	"
0.237	31.69	"
0.154	41.34	"
0.100	45.66	" + $NH_4Br$
0	44.8	$NH_4Br$

In Aq. Sodium Bromide at 30°.

Gms. per 100	Gms. Sat. Sol.	Solid Phase.
$As_2O_3$	$NH_4Br$	
2.19	5.57	$As_2O_3$
2.09	10.89	"
1.88	20.79	"
1.63	30.39	"
1.50	35.75	"
1.20	39.24	$(As_2O_3)_2NaBr$
0.953	43.64	"
0.852	45.99	"
0.719	50.25	" + $NaBr \cdot 2H_2O$
0	±49.5	$NaBr \cdot 2H_2O$

In Aq. Barium Bromide at 30°.

Gms. per 100	Gms. Sat. Sol.	Solid Phase.
$As_2O_3$	$BaBr_2$	
2.09	9.41	$As_2O_3$
2.03	16.88	"
1.97	24.03	"
1.87	24.41	"
1.58	23.49	$(As_2O_3)_2BaBr_2$
0.757	29.09	"
0.678	33.08	"
0.464	38.19	"
0.322	43.02	"
0.277	50.03	" + $BaBr_2 \cdot 2H_2O$
0	50.62	$BaBr_2 \cdot 2H_2O$

In Aq. Barium Chloride at 30°.

Gms. per 100	Gms. Sat. Sol.	Solid Phase.
$As_2O_3$	$BaCl_2$	
2.24	3.84	$As_2O_3$
2.20	8.72	"
2.19	8.86	"
2.15	10.34	"
1.69	9.55	$(As_2O_3)_2BaCl_2$
1.12	13.62	"
0.905	16.93	"
0.737	20.06	"
0.608	23.87	"
0.506	26.54	" + $BaCl_2 \cdot 2H_2O$
0	27.6	$BaCl_2 \cdot 2H_2O$

In Aq. Calcium Bromide at 20°.

Gms. per 100	Gms. Sat. Sol.	Solid Phase.
$As_2O_3$	$CaBr_2$	
1.58	9.65	$As_2O_3$
1.28	20.13	"
0.912	34.90	"
0.789	41	"
0.698	47.67	"
0.513	52.06	"
0.687	58.22	" + $CaBr_2 \cdot 6H_2O$
0	58.20	$CaBr_2 \cdot 6H_2O$

In Aq. Calcium Chloride at 19.5°-20°.

Gms. per 100	Gms. Sat. Sol.	Solid Phase.
$As_2O_3$	$CaCl_2$	
1.78	0	$As_2O_3$
1.39	12.66	"
1.01	23.09	"
0.865	27.68	"
0.757	31.85	"
0.697	36.01	"
0.675	41.92	" + $CaCl_2 \cdot 6H_2O$
0	42.7	$CaCl_2 \cdot 6H_2O$

100 gms. 95% formic acid dissolve 0.02 gm.  $As_2O_3$  at 19.8°.

(Aschan, 1913.)



# ARSENIC OXIDES

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## SOLUBILITY OF ARSENIC TRIOXIDE IN AQUEOUS SALT SOLUTIONS. (Contd.)

In Aq. Lithium Bromide at 30°.			In Aq. Lithium Chloride at 30°.		
Gms. per 100	Gms. Sat. Sol.	Solid Phase.	Gms. per 100	Gms. Sat. Sol.	Solid Phase
As <sub>2</sub> O <sub>3</sub>	LiBr.		As <sub>2</sub> O <sub>3</sub>	LiCl.	
2.26	0	As <sub>2</sub> O <sub>3</sub>	1.69	7.57	As <sub>2</sub> O <sub>3</sub>
1.69	11.68	"	1.15	15.30	"
1.20	23.23	"	0.77	22.67	"
0.734	35.54	"	0.54	29.04	"
0.534	37	" + (As <sub>2</sub> O <sub>3</sub> ) <sub>2</sub> LiBr	0.43	35.37	"
0.332	42.62	(As <sub>2</sub> O <sub>3</sub> ) <sub>2</sub> LiBr	0.39	41.13	"
0.281	43.87	"	0.385	43.01	"
0.198	46.75	"	0.41	45.12	" + LiCl
0	59.62	LiBr.H <sub>2</sub> O	0	46.1	LiCl.H <sub>2</sub> O
In Aq. Potassium Bromide at 30°.			In Aq. Potassium Iodide at 30°.		
Gms. per 100	Gms. Sat. Sol.	Solid Phase.	Gms. per 100	Gms. Sat. Sol.	Solid Phase
As <sub>2</sub> O <sub>3</sub>	KBr.		As <sub>2</sub> O <sub>3</sub>	KI.	
2.25	0.336	As <sub>2</sub> O <sub>3</sub> + D	2.26	0	As <sub>2</sub> O <sub>3</sub>
0.818	2.51	D	0.772	1.19	(As <sub>2</sub> O <sub>3</sub> ) <sub>2</sub>
0.460	12.78	"	0.296	9.56	"
0.327	22.59	"	0.183	22.89	"
0.290	27.40	"	0.150	34.31	"
0.275	36.98	"	0.119	40.79	"
0.207	39.04	"	0.081	47.07	"
0.166	42.07	" + KBr	0.115	53.51	"
0	±41.3	KBr	0.134	60.54	"
D varies from (As <sub>2</sub> O <sub>3</sub> ) <sub>2</sub> KBr to (As <sub>2</sub> O <sub>3</sub> ) <sub>7</sub> (KBr) <sub>4</sub> .			0	61.5	K
In Aq. Strontium Bromide at 30°.			In Aq. Strontium Chloride at 30°.		
Gms. per 100	Gms. Sat. Sol.	Solid Phase.	Gms. per 100	Gms. Sat. Sol.	Solid Phase
As <sub>2</sub> O <sub>3</sub>	SrBr <sub>2</sub> .		As <sub>2</sub> O <sub>3</sub>	SrCl <sub>2</sub> .	
1.69	11.69	As <sub>2</sub> O <sub>3</sub>	2.14	6.27	As <sub>2</sub> O <sub>3</sub>
1.74	22.09	"	1.92	13.67	"
1.48	31.98	"	1.67	21.29	"
1.25	41.91	"	1.46	27.46	"
1.07	46.87	"	1.28	34.03	"
0.991	48.91	" + SrBr <sub>2</sub> .6H <sub>2</sub> O	1.23	36.16	" + SrCl <sub>2</sub> .6H <sub>2</sub> O
0	49.11	SrBr <sub>2</sub> .6H <sub>2</sub> O	0	37.5	SrCl <sub>2</sub> .6H <sub>2</sub> O

## ARSENIC PENTOXIDE As<sub>2</sub>O<sub>5</sub>.

### SOLUBILITY IN WATER.

(Menzies and Potter, 1912.)

t°.	Gms. As <sub>2</sub> O <sub>5</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. As <sub>2</sub> O <sub>5</sub> per 100 Gms. Sat. Sol.	Solid Phase
-5	10.6	Ice	-10	36.2	As <sub>2</sub> O <sub>5</sub> .4H <sub>2</sub> O
-10	15.6	"	0	37.3	"
-20	21.3	"	+10	38.3	"
-30	25.1	"	20	39.7	"
-40	27.8	"	29.5	41.4	" + 3As <sub>2</sub> O <sub>5</sub>
-50	29.9	"	40	41.6	3As <sub>2</sub> O <sub>5</sub> .51
-59 Eutec.	31.7	Ice + As <sub>2</sub> O <sub>5</sub> .4H <sub>2</sub> O	60	42.2	"
-50	32.6	As <sub>2</sub> O <sub>5</sub> .4H <sub>2</sub> O	80	42.9	"
-40	33.5	"	100	43.4	"
-30	34.4	"	120	43.7	"
-20	35.4	"	140	44.5	"

100 gms. 95% HCOOH dissolve 7.6 gms. As<sub>2</sub>O<sub>5</sub> at 19°.

(Aschan, 1



**ARSENIOUS SULFIDE**  $As_2S_3$ .1000 cc. water dissolve 0.000517 gm.  $As_2S_3$  at 18°.

(Weigel, 1907.)

Data for the fusion-points of mixtures of arsenious sulfide and silver sulfide are given by Jaeger and Van Klooster (1912).

**ASPARAGINE**  $C_4H_7N_2O_3 \cdot H_2O$ .SOLUBILITY  $\beta$ -L-ASPARAGINE,  $C_4H_7N_2O_3 \cdot H_2O$ , AND OF  $\beta$ -L-ASPARAGINIC ACID,  $C_4H_7NO_4$ , IN WATER.

(Bräcker — Z. physik. Chem. 47, 613, '04.)

$\beta$ -L-Asparagine.				$\beta$ -L-Asparaginic Acid.			
t°.	Gms. $C_4H_7N_2O_3 \cdot H_2O$ per 100 g. $H_2O$ .	t°.	Gms. $C_4H_7N_2O_3 \cdot H_2O$ per 100 g. $H_2O$ .	t°.	Gms. $C_4H_7NO_4$ per 100 g. $H_2O$ .	t°.	Gms. $C_4H_7NO_4$ per 100 g. $H_2O$ .
0.7	0.9546	55.5	10.650	0.2	0.2674	51.0	1.2746
7.9	1.4260	71.7	19.838	9.5	0.4042	63.5	1.8147
17.5	2.1400	87.0	36.564	16.4	0.5176	70.0	2.3500
28.0	3.1710	98.0	52.475	31.5	0.7514	80.5	3.2106
41.4	5.6500			40.0	0.9258	97.4	5.3746

100 gms.  $H_2O$  dissolve 2.4 gms. asparagine at 20°–25°.

(Dehn, 1917.)

100 gms. pyridine dissolve 0.03 gm. asparagine at 20°–25°.

100 gms. 50% aq. pyridine dissolve 0.15 gm. asparagine at 20°–25°.

100 gms. trichlorethylene dissolve 0.018 gm. asparagine at 15°. (Wester &amp; Bruins, 1914.)

Data for the solubility of asparaginic acid in aqueous salt solutions are given by Würger (1914).

**ASPIRIN** (Acetyl salicylic acid)  $C_9H_8(OCH_2CO)COOH$ .

100 gms. water dissolve 0.25 gm. aspirin at room temperature. (Squire and Caines, 1905.)

100 cc. 90% alcohol dissolve 20 gm. aspirin at room temperature. "

**ATROPINE**  $C_{17}H_{23}NO_3$ .SOLUBILITY OF ATROPINE,  $C_{17}H_{23}NO_3$ , AND OF ATROPINE SULFATE, $(C_{17}H_{23}NO_3)_2 \cdot SO_3(OH)_2$ , IN WATER AND OTHER SOLVENTS.

(U. S. P.; Müller, 1903.)

Solvent.	t°.	Grams Atropine per 100 Grams.		Grams Atropine Sulfate per 100 Grams Solvent. (U. S. P.)
		Solution	Solvent. (U. S. P.)	
Water	25	1.782 (20°)	0.222 (0.13*)	263.1
Water	80	...	1.15	454.5
Alcohol	25	...	68.44	27
Alcohol	60	...	111.11	52.6
Ether	25	2.21 (20°)	6.02	0.047
Chloroform	25	68.03 (20°)	64.10	0.161
Benzene	20	3.99	...	...
Carbon Tetrachloride	20	0.661	1.136† (1.76‡)	...
Ethyl Acetate	20	3.88	...	...
Petroleum Ether	20	0.83	...	...
Glycerol	15	...	3	33
Aniline	20	...	34§	...
Diethylamine	20	...	67§	...
Pyridine	20	...	73§	...
Piperidine	20	...	114§	...
50% Aq. Glycerol } + 3% $H_3BO_3$ }	..	10¶	...	...
Oil of Sesame	20	...	0.25*	...

\* Zehi, 1900. † At 17°, Schneidmeyer, 1901. ‡ Gori, 1913. § Scholtz, 1912. ¶ Baroni and Borlinetto, 1911.



## ATROPINE

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### DISTRIBUTION OF ATROPINE BETWEEN WATER AND CHLOROFORM AT 25° (Seidell, 1910a.)

Gms. Atropine Added per 15 cc. H <sub>2</sub> O + 15 cc. CHCl <sub>3</sub> .	Gms. Atropine Recovered per 15 cc.		
	Aqueous Layer (a).	Chloroform Layer (b).	$\frac{b}{a}$ .
0.005	0.0010	0.0057	5.7
0.025	0.0021	0.0256	12.2
0.125	0.0049	0.1246	25.4
0.625	0.0160	0.6267	39.1

## ATROPINE METHYLBROMIDE C<sub>17</sub>H<sub>23</sub>NO<sub>2</sub>.CH<sub>2</sub>Br.

100 gms. water dissolve 100 gms. of the salt at room temp. (Squires and Caines, 1910)  
100 cc. 90% alcohol dissolve 10 gms. of the salt at room temp. " "

## AZELAIC ACID C<sub>7</sub>H<sub>14</sub>(COOH)<sub>2</sub>.

### SOLUBILITY IN WATER. (Lamoureux, 1899.)

t° =	0	15	20	35	50	65
Gms. C <sub>7</sub> H <sub>14</sub> (COOH) <sub>2</sub> per 100 cc. solution =	0.10	0.15	0.24	0.45	0.82	2.20
100 gms. 95% HCOOH dissolve	3.79 gms. azelaic acid at 19.4°. (Aschan, 1910)					

### DISTRIBUTION OF AZELAIC ACID BETWEEN WATER AND ETHER AT 25°. (Chandler, 1908.)

Gms. C <sub>7</sub> H <sub>14</sub> (COOH) <sub>2</sub> per 1000 cc.		Gms. C <sub>7</sub> H <sub>14</sub> (COOH) <sub>2</sub> per 1000 cc.	
Aq. Layer.	Ether Layer	Aq. Layer.	Ether Layer.
0.06	0.47	0.40	5.83
0.10	1.10	0.50	7.40
0.20	2.71	0.58	8.65
0.30	4.26		

## AZOBENZENE C<sub>6</sub>H<sub>5</sub>.N<sub>2</sub>.C<sub>6</sub>H<sub>5</sub>.

### SOLUBILITY OF AZOBENZENE IN SEVERAL BINARY MIXTURES. (Timmermans, 1907.)

Solvent, Binary Mixture of:	t°.	Gms. (C <sub>6</sub> H <sub>5</sub> N) <sub>2</sub> 100 Gms. Sat. Sol.
34.9% Butyric Acid + 65.1% H <sub>2</sub> O (= sat. sol. at 2.3°)	6.4	0.46
	10	0.55
	20	1.13
	30	1.92
	40.6	2.95
36% Triethylamine + 64% H <sub>2</sub> O (= sat. sol. at 19.1°)	8.8	3.22
	11	2.57
	14	1.66
	17.4	0.54
	69.3	0.43
36.5% Phenol + 63.5% H <sub>2</sub> O (= sat. sol. at 65.3°)	72.7	0.47
	80	1.47
	90	2.43
	100	3.45
	23.9	0.52
71.4% Phenol + 28.6% H <sub>2</sub> O (= sat. sol. at 20.6°)	25.2	0.87
	40	4.45
	60	10.35
	72.6	133.40
	56.9	0.54
46% Succinic Nitrile + 54% H <sub>2</sub> O (= sat. sol. at 54°)		



## SOLUBILITY OF AZOBENZENE IN SEVERAL ALCOHOLS.

(Timofeiew, 1894.)

Solvent.	t°.	Gms. (C <sub>6</sub> H <sub>5</sub> N) <sub>2</sub> per 100 Gms. Sat. Sol.	Solvent.	t°.	Gms. (C <sub>6</sub> H <sub>5</sub> N) <sub>2</sub> per 100 Gms. Sat. Sol.
Methyl Alcohol	9.5	3.8	Ethyl Alcohol	10.5	5.88
" "	10.5	3.95	Propyl Alcohol	9.5	5.42
Ethyl Alcohol	9.5	5.29	" "	10.5	6.02

## SOLUBILITY OF AZOBENZENES IN WATER AND IN PYRIDINE.

(Dehn, 1917.)

Solvent.	t°.	Gms. Each Compound (Determined Separately) per 100 Gms. Solvent:		
		Azobenzene.	Diazoamino- benzene.	Dimethylamino- azobenzene.
Water	20-25	0.03	0.05	0.016
Pyridine	20-25	76.44	136.7	27.90
Aq. 50% Pyridine	20-25	16.78	67.7	4.51

Hydroxy-AZOBENZENE C<sub>6</sub>H<sub>5</sub>N:N.C<sub>6</sub>H<sub>4</sub>OH.1000 cc. sat. solution in H<sub>2</sub>O contain 0.0225 gm. C<sub>6</sub>H<sub>5</sub>N:N.C<sub>6</sub>H<sub>4</sub>OH at 25°.1000 cc. sat. solution in H<sub>2</sub>O sat. with C<sub>6</sub>H<sub>6</sub> contain 0.0284 gm. C<sub>6</sub>H<sub>5</sub>N:N.C<sub>6</sub>H<sub>4</sub>OH at 25°.1000 cc. sat. solution in C<sub>6</sub>H<sub>6</sub> sat. with H<sub>2</sub>O contain 15.20 gms. C<sub>6</sub>H<sub>5</sub>N:N.C<sub>6</sub>H<sub>4</sub>OH at 25°.Distribution results for hydroxyazobenzene between benzene and water gave:  
conc. in C<sub>6</sub>H<sub>6</sub> + conc. in H<sub>2</sub>O = 539 at 25°.Amino-AZOBENZENE C<sub>6</sub>H<sub>5</sub>N:N.C<sub>6</sub>H<sub>4</sub>NH<sub>2</sub>.Distribution results for amino azobenzene between benzene and water gave:  
conc. in C<sub>6</sub>H<sub>6</sub> + conc. in H<sub>2</sub>O = 3,173 at 25°.

## AZOANISOL, AZOBENZENE, AZOPHENETOL, etc.

SOLUBILITY DATA, DETERMINED BY THE FREEZING-POINT METHOD (see footnote, p. 1), ARE GIVEN FOR THE FOLLOWING MIXTURES:

p Azoisol	Azobenzene
+ p Azoxyanisol (1)	+ Benzeneazonaphthalene (9)
" + p Azoanisolphenetol (1)	" + Benzil (8)
" + Methylpropylazophenol (1)	" + Benzoin (8)
" + p Azophenetol (1)	" + Benzylaniline (7), (9), (10), (11), (12)
p Azoxyanisol	" + Dibenzyl (7), (13), (14), (12)
+ p Azoanisolphenetol (1)	" + Diphenyl (9)
" + p Azoxyphenetol (3), (4)	" + p Dimethoxystilbene (7)
" + Benzene (2)	" + Hydrobenzene (7)
" + Ethylene bromide (2)	" + Stilbene (7), (9)
" + Hydroquinone (5)	" + Tolane (7)
" + Benzophenone (5)	Hydrazobenzene
" + p Methoxycinnamic Acid (5)	+ Benzoin (8)
" + Nitrobenzene (2)	p Azophenetol
p Azoanisolphenetol	+ p Azoxyphenetol (1)
" + Azophenetol (1)	" + p Dipropylazophenetol (1)
" + p Dipropylazophenetol (1)	p Azoxyphenetol
Azobenzene	+ Cholesterylisobutyrate (4)
+ Azoxybenzene (6)	" + Cholesterylpropionate (4)
" + p Azotoluene (7)	" + Cholesterylbenzoate (4)
" + p Azonaphthalene (7)	" + p Methoxycinnamate (4)
" + Benzalaniline (7)	p Azotoluene
p Azobenzoic Acid Ethyl Ester	+ Stilbene (7)
+ p Azoxybenzoic Acid Ethyl Ester (5)	

(1) Bogojawlsky and Winogrodow, 1907; (2) Bogojawlski, Winogrodow and Bogolubow, 1906; (3) Ratignaz and Rotaiski, 1906; (4) Prins, 1909; (5) de Kock, 1904; (6) Hartley and Stewart, 1914; (7) Pascal and Normand, 1913; (8) Vanstone, 1913; (9) Beck, 1904; (10) Isaac (1910-11); (11) Jaeger, 1907; (12) Hasselblatt, 1913; (13) Garelli and Calzolari, 1899; (14) Bruni and Gorni, 1899.



**AZOLITMINE**

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**AZOLITMINE**  $C_7H_7NO_4$ .

100 gms.  $H_2O$  dissolve 39.5 gms. azolitmine at  $20^\circ-25^\circ$ . (Dehn, 19  
 100 gms. pyridine dissolve 0.05 gm. azolitmine at  $20-25^\circ$ . "  
 100 gms. aq. 50% pyridine dissolve 0.12 gm. azolitmine at  $20^\circ-25^\circ$ . "

**AZOPHENETOL** (*p*)  $C_6H_5N_2.C_6H_4.OC_2H_5$ 

## SOLUBILITY IN 100 PER CENT ACETIC ACID.

(Dreyer and Rotarski — Chem. Centr. 76, II, 1016, '05.)

$t^\circ =$	89.2	91	93	95.6	97.2	99
Mols. per liter.	0.153	0.176	0.185	0.209	0.232	0.2

A break in the curve at  $94.7^\circ$  corresponds to the transition temperature of  $\alpha$  modification into the  $\beta$  modification.

**BARIUM ACETATE**  $Ba(CH_3COO)_2$ .

## SOLUBILITY IN WATER.

(Walker and Fyffe, 1903; Krasnicki, 1887, gives incorrect results.)

$t^\circ$ .	Gms. $Ba(CH_3COO)_2$ per 100 Gms. Water. Solution.		Solid Phase.	$t^\circ$ .	Gms. $Ba(CH_3COO)_2$ per 100 Gms. Water. Solution.		Solid Phase.
0.3	58.8	37.0	$Ba(C_2H_5O_2)_2.3H_2O$	40.5	79.0	44.1	$Ba(C_2H_5O_2)_2$
7.9	61.6	38.1	"	41.5	78.7	44.0	"
17.5	69.2	40.9	"	44.5	77.9	43.8	"
21.6	72.8	42.1	"	51.8	76.5	43.4	"
24.1	78.1	43.9	"	63.0	74.6	42.7	"
26.2	76.4	43.3	$Ba(C_2H_5O_2)_2.H_2O$	73.0	73.5	42.4	"
30.6	75.1	42.9	"	84.0	74.0	42.5	"
35.0	75.8	43.1	"	99.2	74.8	42.8	"
39.6	77.9	43.8	"				

Transition temperatures  $24.7^\circ$  and  $41^\circ$ .

100 cc. 97% ethyl alcohol dissolve 0.0723 gm. barium acetate at room tem  
 (Crowell, 1)

SOLUBILITY OF BARIUM ACETATE IN AQUEOUS SOLUTIONS OF ACETIC A  
 AT  $25^\circ$ .

(Iwaki, 1914.)

Mols. per 100 $CH_3COOH$ .	Mols. Sat. Sol. $(CH_3COO)_2Ba$ .	Solid Phase.	Mols. per 100 $CH_3COOH$ .	Mols. Sat. Sol. $(CH_3COO)_2Ba$ .	Solid Ph
0	5.18	$(CH_3COO)_2Ba.3H_2O$	28.72	4.52	3.3.II
0.41	5.21	"	36.54	5.60	"
1.40	5.34	" + 3.3.II	42.08	7.85	"
1.46	5.32	3.3.II	46.51	8.87	" +
3.30	3.48	"	51.98	8.62	1.3
10.23	3.14	"	65.77	8.40	"
20.60	3.62	"	85.27	7.36	"

3.3.II =  $3(CH_3COO)_2Ba.3CH_3COOH.11H_2O$ , 1.3 =  $(CH_3COO)_2Ba.3CH_3CO$

**BARIUM ARSENATE**  $Ba_3(AsO_4)_2$ .

100 gms.  $H_2O$  dissolve 0.055 gm.  $Ba_3(AsO_4)_2$ ; 100 gms. 5% NE  
 dissolve 0.195 gm., and 100 gms. 10%  $NH_4OH$  dissolve 0.003 ;  
 $Ba_3(AsO_4)_2$

(Field — J. Ch. Soc. 11 6, 1

**BARIUM BENZOATE**  $(C_6H_5COO)_2Ba.6H_2O$ .

100 gms. sat. aqueous solution contain 4.3 gms. salt (anhydrous ?) at  
 and 10.1 gms. at  $100^\circ$ . (Tarugi and Checchi, 1



## BARIUM BORATES.

## SOLUBILITY IN AQUEOUS BORIC ACID SOLUTIONS AT 30°.

(Sborgi, 1913.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
BaO <sub>2</sub>	BaO.		BaO <sub>2</sub>	BaO.	
3.6	0.04	H <sub>2</sub> BO <sub>3</sub> +1.3.7	0.3	0.23	1.3.7
3.4	0.04	1.3.7	0.3	0.31	1.37+1.1.4
2.5	0.04	"	0.2	0.8	1.1.4
2.0	0.04	"	0.2	1.2	"
1.0	0.05	"	0.24	4.8	"
0.5	0.09	"	0.26	5.8	1.14+Ba(OH) <sub>2</sub>
0.4	0.12	"	0.08	5.3	Ba(OH) <sub>2</sub>

1.3.7 = BaO.3B<sub>2</sub>O<sub>3</sub>.7H<sub>2</sub>O (Triborate); 1.1.4 = BaO.B<sub>2</sub>O<sub>3</sub>.4H<sub>2</sub>O (Metaborate).  
The original results were plotted and above figures read from curve.

BARIUM BROMATE Ba(BrO<sub>3</sub>)<sub>2</sub>H<sub>2</sub>O.

## SOLUBILITY IN WATER.

(Trautz and Anschütz, 1906; Rammelsberg, 1841.)

t°	Gms. Ba(BrO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Solution.	t°	Gms. Ba(BrO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Solution.	t°	Gms. Ba(BrO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Solution.
- 0.034	0.28	30	0.95	70	2.922
0	0.286	40	1.31	80	3.521
+10	0.439	50	1.72	90	4.26
20	0.652	60	2.271	98.7	5.256
25	0.788			99.65	5.39

## SOLUBILITY OF BARIUM BROMATE IN AQUEOUS SOLUTIONS OF SALTS AT 25°.

(Harkins, 1911.)

Conc. of Salt in Gms. Equiv- alents per Liter.	Gms. Ba(BrO <sub>3</sub> ) <sub>2</sub> Dissolved per Liter in Aqueous Sol. of:			
	KNO <sub>3</sub> .	Ba(NO <sub>3</sub> ) <sub>2</sub> .	KBrO <sub>3</sub> .	Mg(NO <sub>3</sub> ) <sub>2</sub> .
0	7.93 (1.0038)	7.93	7.93	7.93
0.025	8.62 (1.0059)	7.22 (1.0059)	5.216 (1.0046)	...
0.050	9.91 (1.0080)	6.83 (1.0083)	3.415 (1.0062)	...
0.100	10.25 (1.0120)	6.415 (1.0132)	1.72 (1.0109)	8.196 (1.0114)
0.200	...	6.230 (1.0233)	...	...

Figures in parentheses show densities of the sat. sols. at  $\frac{25^\circ}{4}$ .

BARIUM BROMIDE BaBr<sub>2</sub>.2H<sub>2</sub>O.

## SOLUBILITY IN WATER.

(Kremers — Pogg. Ann. 99, 47, '56; Etard — Ann. chim. phys. [7] 2, 540, '94.)

t°.	Gms. BaBr <sub>2</sub> per 100 Grams.			t°.	Gms. BaBr <sub>2</sub> per 100 Grams.		
	Water. (Kremers.)	Solution. (Kremers.) (Etard.)			Water. (Kremers.)	Solution. (Kremers.) (Etard.)	
-20	...	...	45.6	40	114	53.2	51.5
0	98	49.5	47.5	50	118	54.1	52.5
10	101	50.2	48.5	60	123	55.1	53.5
20	104	51.0	49.5	70	128	56.1	54.5
25	106	51.4	50.0	80	135	57.4	55.5
30	109	52.1	50.6	100	149	60.0	57.8
				140	...	...	59.4

Sp. Gr. of saturated solution at 19.5° = 1.710.



## BARIUM BROMIDE

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Data for the system Barium Bromide + Barium Oxide +  $H_2O$  at  $25^\circ$  given by Milikau (1916).

### SOLUBILITY OF MIXTURES OF BARIUM BROMIDE AND BARIUM IODIDE IN WATER AT DIFFERENT TEMPERATURES.

(Etard.)

$t^\circ$ .	Grams per 100 Gms. Solution.		$t^\circ$ .	Grams per 100 Gms. Solution.	
	$BaBr_2$ .	$BaI_2$ .		$BaBr_2$ .	$BaI_2$ .
-16	4.8	58.4	170	11.0	67.4
+60	5.5	66.0	210	14.9	67.7
135	9.2	67.2	Both salts present in solid phase.		

### SOLUBILITY OF BARIUM BROMIDE IN METHYL AND ETHYL ALCOHOL

(de Bruyn — Z. physik. Chem. 10, 783, '92; Richards — Z. anorg. Chem. 3, 455, '93; Rohland — *ibid.* 15, 412, '97.)

$t^\circ$ .	Parts $BaBr_2$ per 100 parts Aq. $C_2H_5OH$ of:			Parts $BaBr_2 \cdot 2H_2O$ per 100 parts of Aq. $CH_3OH$ of:		
	100%.	97%.	87%.	100%.	93.5%.	50%.
15.0	..	0.48 ( $BaBr_2 \cdot 2H_2O$ )	..	45.9	27.3	4.0
22.5	3	...	6	56.1	...	...

100 gms. sat. solution in methyl alcohol at the crit. temp. contain 0.4 gm  $BaBr_2$ . (Centnerswer, 1911)

Data for the lowering of the melting point of  $BaBr_2$  by  $BaF_2$  and by  $BaCl_2$  are given by Ruff and Plato (1903).

## BARIUM PERBROMIDE $BaBr_4$ .

Data for the formation of barium perbromide in aqueous solutions at  $25^\circ$  given by Herz and Bulla (1911). See reference calcium perbromide, p. 189.

## BARIUM BUTYRATE $Ba(C_4H_7O_2)_2 \cdot 2H_2O$ .

### SOLUBILITY IN WATER.

(Deszathy — Monatsh. Chem. 14, 249, '93.)

$t^\circ$ .	Gms. $Ba(C_4H_7O_2)_2$ per 100 Gms.		$t^\circ$ .	Gms. $Ba(C_4H_7O_2)_2$ per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	37.42	27.24	50	36.44	26.77
10	36.65	26.82	60	37.68	27.36
20	36.12	26.55	70	39.58	28.36
30	35.85	26.38	80	42.13	29.64
40	35.82	26.37			

100 gms. 97% ethyl alcohol dissolve 0.17 gm. barium butyrate at ord. temp. (Crowell, 1911)

## BARIUM CAMPHORATE $BaC_{10}H_{16}O_4 \cdot 4H_2O$ .

### SOLUBILITY OF BARIUM CAMPHORATE IN AQUEOUS SOLUTIONS OF CAMPHOR ACID AT $16^\circ$ - $17^\circ$ .

(Jungfleisch and Landrieu, 1914.)

Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
Camphoric Acid.	Barium Camphorate.	Solid Phase.	Camphoric Acid.	Barium Camphorate.	Solid Phase.
0.68	0.134	d Camphoric ac. + 1.3	0.48	22.71	1.3
0.84	0.150	"	0.45	32.19	"
0.693	0.20	1.3	0.50	37.22	"
0.38	2.59	"	0.51	40.99	1.3 + Ba Camphor
0.44	11.10	"	0	42.59	Ba Camphorate

1.3 = Barium tetracamphorate,  $C_{10}H_{16}O_4 \cdot Ba_3C_{10}H_{16}O_4$ .



## BARIUM CAPROATE AND BARIUM ISO CAPROATE.

## SOLUBILITY IN WATER.

(Kulisch, 1893.)

Barium Caproate (Methyl  $\beta$  Pentan.)  
 $\text{Ba}(\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{COO})_2$ 

(König, 1893.)

Barium Iso Caproate (Methyl  $\alpha$  Pentan.)  
 $\text{Ba}(\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{COO})_2$ 

t°.	Gms. $\text{Ba}(\text{C}_6\text{H}_{11}\text{O}_2)_2$ per 100 Gms.		Solid Phase.	Gms. $\text{Ba}(\text{C}_6\text{H}_{11}\text{O}_2)_2$ per 100 Gms.		Solid Phase.
	Water.	Solution.		Water.	Solution.	
0	11.71	10.49	$\text{Ba}(\text{C}_6\text{H}_{11}\text{O}_2)_{2-3\frac{1}{2}}\text{H}_2\text{O}$	14.34	12.54	$\text{Ba}(\text{C}_6\text{H}_{11}\text{O}_2)_{2-4}\text{H}_2\text{O}$
10	8.38	7.73	"	13.33	11.77	"
20	6.89	6.45	"	12.67	11.26	"
30	5.87	5.55	"	12.37	11.01	"
40	5.79	5.47	"	12.42	11.05	"
50	6.63	6.21	"	12.83	11.38	"
60	8.39	7.74	"	13.63	11.99	"
70	11.09	9.08	"	14.68	12.80	"
80	14.71	12.82	"	16.24	13.97	"
90	19.28	16.16	"	17.95	15.23	"

BARIUM CARBONATE  $\text{BaCO}_3$ .

## SOLUBILITY IN WATER.

(Holleman, Kohlrausch and Rose, 1893.)

Electrolytic conductivity method used.

1 liter  $\text{H}_2\text{O}$  dissolves 0.016 gm.  $\text{BaCO}_3$  at  $8.8^\circ$ , 0.022 gm. at  $18^\circ$ , and 0.024 gm. at  $24^\circ$ .SOLUBILITY OF BARIUM CARBONATE IN WATER CONTAINING  $\text{CO}_2$ .

The average of several determinations at about  $10^\circ$ , by Bineau, Lassaigne, Foucroy and Bergmann is 1.10 gms.  $\text{BaCO}_3$  per liter water. Wagner (Z. anal. Ch. 6, 167, '67) gives 7.25 gms.  $\text{BaCO}_3$  per liter of water saturated with  $\text{CO}_2$  at 4-6 atmospheres pressure.

Eleven determinations by McCoy and Smith (1911), of the solubility of barium carbonate at  $25^\circ$  in water in contact with pressures of  $\text{CO}_2$  varying from 0.2 to 30 atmospheres, showed that a maximum solubility is reached at 22 atmospheres (see also calcium carbonate, p. 192), at which point the saturated solution contains 0.727 mols. = 45.1 gms.  $\text{H}_2\text{CO}_3$  per liter and 0.028 mols. = 7.3 gms.  $\text{Ca}(\text{HCO}_3)_2$  per liter. The equilibrium constant is  $k = 2.24 \times 10^{-2}$  and the solubility product  $\text{Ba} \times \text{CO}_3 = k_2 = 8.1 \times 10^{-9}$ .

SOLUBILITY OF BARIUM CARBONATE IN AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE AT  $30^\circ$ .

(Kernot, d'Agostino and Pellegrino, 1908.)

Gms. per 1000 cc. $\text{H}_2\text{O}$ .		Solid Phase.	Gms. per 1000 cc. $\text{H}_2\text{O}$ .		Solid Phase.
$\text{BaCO}_3$	$\text{NH}_4\text{Cl}$		$\text{BaCO}_3$	$\text{NH}_4\text{Cl}$	
0.035	0	$\text{BaCO}_3$	2.245	335.70	$\text{BaCO}_3$
0.521	8.099	"	2.706	358.66	"
1.333	64.536	"	2.630	418.33	$\text{NH}_4\text{Cl}$
1.596	92.593	"	2.151	414.71	"
2	160.265	"	1.558	413.77	"
2.093	186.775	"	0.730	410.16	"
2.256	268.920	"	0	397.58	"

Data are also given for  $25^\circ$ . Some uncertainty exists as to the terms in which the results are expressed. In some cases the column headings read "Gms. per liter of  $\text{H}_2\text{O}$ " and in others "Gms. per liter of solution." The saturation was effected by adding just the necessary amount of one constituent to cause the disappearance of the last particle of the other. The amounts so added were determined by weighing the flasks. At high concentrations of the two salts, the sudden increase in solubility appears to indicate a molecular combination.



## SOLUBILITY OF BARIUM CARBONATE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE AND OF SODIUM CHLORIDE.

(Cantoni and Goguelis, 1905.)

In KCl at B.pt. of Sol.		In NaCl at B.pt. of Sol.		In 10% KCl Sol.		In 10% NaCl	
Gms. KCl per 100 Gms. Sol.	Gms. BaCO <sub>3</sub> per 1000 cc. Sat. Sol.	Gms. NaCl per 100 Gms. Sol.	Gms. BaCO <sub>3</sub> per 1000 cc. Sat. Sol.	t°.	Gms. BaCO <sub>3</sub> per 1000 cc. Sat. Sol.	t°.	Gms. Ba per 100 Sat. S.
0.15	0.0847	0.15	0.0587	10	0.2175	10	0.101
1.00	0.1781	1	0.0787	20	0.2408	20	0.111
3	0.2667	3	0.1056	40	0.2972	40	0.121
10	0.4274	10	0.1575	60	0.3491	40	0.131
30	0.5550	30	0.2784	80	0.4049	40	0.141

Barium carbonate boiled with aqueous NH<sub>4</sub>Cl is slowly but completely decomposed. The time required varies inversely as the concentration of the NH<sub>4</sub> solution.

Data are also given for solubility in 10% aqueous KCl and NaCl at the boiling point, the time factor being varied from 1 to 198 hours.

Data for lowering of the melting point of BaCO<sub>3</sub> by Na<sub>2</sub>CO<sub>3</sub> are given by Sac (1911-12).

BARIUM CHLORATE Ba(ClO<sub>3</sub>)<sub>2</sub>·H<sub>2</sub>O.

## SOLUBILITY IN WATER.

(Carlson, 1910; Trautz and Anschütz, 1906.)

t°.	Sp. Gr. of Sat. Sol.	Gms. Ba(ClO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.		t°.	Sp. Gr. of Sat. Sol.	Gms. Ba(ClO <sub>3</sub> ) <sub>2</sub> per Gms. Sat. Sol.	
0	1.195	20.3*	16.90†	40	1.355	35.8*	33.1
10	...	24.3	21.23	60	1.433	42.6	40.1
20	1.274	28.2	25.26	80	1.508	48	45.1
25	...	30	27.53	100	1.580	53.1	51.1
30	...	32	29.43	105.6 b. pt.	1.600	54.6	52.1

\* C.

† (T and A.)

The determinations of Trautz and Anschütz appear to have been made with very great care. The original paper of Carlson was not available and it was impossible to explain the discrepancy between the two sets of results.

BARIUM PERCHLORATE Ba(ClO<sub>4</sub>)<sub>2</sub>·3H<sub>2</sub>O.

## SOLUBILITY IN WATER.

(Carlson, 1910.)

t°.	Sp. Gr. of Sat. Sol.	Gms. Ba(ClO <sub>4</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	t°.	Sp. Gr. of Sat. Sol.	Gms. Ba(ClO <sub>4</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.
0	1.782	67.3	80	2.114	83.2
20	1.912	74.3	100	2.155	84.9
40	2.009	78.2	120	2.195	86.6
60	2.070	81	140	2.230	88.3

BARIUM CHLORIDE BaCl<sub>2</sub>·2H<sub>2</sub>O.

## SOLUBILITY IN WATER.

(Mulder, Engel, 1888; Etard, 1894.)

t°.	Gms. BaCl <sub>2</sub> per 100 Gms.		t°.	Gms. BaCl <sub>2</sub> per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	31.6	24	60	46.4	31.3
10	33.3	25	70	49.4	33.1
20	35.7	26.3	80	52.4	34.4
25	37	27	100	58.8	37
30	38.2	27.7	130	59.5	37.3
40	40.7	28.9	160	63.6	38.9
50	43.6	30.4	215	75.9	43.1

Sp. Gr. of solution saturated at 0° = 1.25; at 20° = 1.27.



SOLUBILITY OF MIXTURES OF BARIUM CHLORIDE AND AMMONIUM CHLORIDE IN WATER.

At 30°. (Schreinemakers, 1908.)			At Varying Temps. (Schreinemakers, 1910b.)		
Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
BaCl <sub>2</sub>	NH <sub>4</sub> Cl			BaCl <sub>2</sub>	NH <sub>4</sub> Cl
22.16	5.71	BaCl <sub>2</sub> ·2H <sub>2</sub> O	16.2	8.07	16.10
18.36	10.06	"	0	8.22	19.26
15.42	13.84	"	30	8.19	24.89
10.89	20.01	"	40	8.40	26.93
8.33	24.69	"	50	8.55	29.53
7.97	25.92	BaCl <sub>2</sub> ·2H <sub>2</sub> O + NH <sub>4</sub> Cl			
3.56	27.47	NH <sub>4</sub> Cl			

SOLUBILITY OF BARIUM CHLORIDE IN AQUEOUS SOLUTIONS OF BARIUM HYDROXIDE AND VICE VERSA AT 30°.  
(Schreinemakers, 1909-1910, 1910b.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
BaCl <sub>2</sub>	BaO.		BaCl <sub>2</sub>	BaO.	
27.6	0	BaCl <sub>2</sub> ·2H <sub>2</sub> O	18.67	4.61	BaCl(OH)·2H <sub>2</sub> O + BaO·9H <sub>2</sub> O
27.42	1.78	"	18.04	4.62	BaO·9H <sub>2</sub> O
27.36	1.77	" + BaCl(OH)·2H <sub>2</sub> O	17.08	4.60	"
24.98	2.33	BaCl(OH)·2H <sub>2</sub> O	12.81	4.58	"
21.46	3.27	"	10.77	4.45	"
19.18	4.67	"	0	4.99	"

SOLUBILITY OF MIXTURES OF BARIUM CHLORIDE AND BARIUM NITRATE IN WATER:

At 30°. (Coppadoro, 1912, 1913.)			At Varying Temps. (Etard, 1894.)		
Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
BaCl <sub>2</sub>	Ba(NO <sub>3</sub> ) <sub>2</sub>			BaCl <sub>2</sub>	Ba(NO <sub>3</sub> ) <sub>2</sub>
6.06	9.55	Ba(NO <sub>3</sub> ) <sub>2</sub>	0	22.5	4.3
13.75	8.20	"	20	24.5	6
16.14	7.92	"	40	26.5	7.5
22.70	7.94	"	60	28.5	9.5
26.11	7.88	Ba(NO <sub>3</sub> ) <sub>2</sub> + BaCl <sub>2</sub> ·2H <sub>2</sub> O	100	31	14
26.64	5.37	BaCl <sub>2</sub> ·2H <sub>2</sub> O	140	32	20
26.91	4.13	"	180	33	26
27.38	1.58	"	210	32	32

SOLUBILITY OF BARIUM CHLORIDE IN AQUEOUS SOLUTIONS OF COPPER CHLORIDE AT 30° AND VICE VERSA.  
(Schreinemakers and de Baat, 1908-09.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
BaCl <sub>2</sub>	CuCl <sub>2</sub>		BaCl <sub>2</sub>	CuCl <sub>2</sub>	
0	43.95	CuCl <sub>2</sub> ·2H <sub>2</sub> O	5.49	30.76	BaCl <sub>2</sub> ·2H <sub>2</sub> O
1.25	42.45	"	10.13	21.76	"
3.08	42.07	" (unstable)	17.08	11.49	"
2.72	42.36	CuCl <sub>2</sub> ·2H <sub>2</sub> O + BaCl <sub>2</sub> ·2H <sub>2</sub> O	22.78	5.13	"
2.84	41.18	BaCl <sub>2</sub> ·2H <sub>2</sub> O	27.6	0	"
3.98	37.42	"			

Solubility data have been determined for the following systems:

BaCl <sub>2</sub> ·2H <sub>2</sub> O	+ CuCl <sub>2</sub> ·2H <sub>2</sub> O	+ NH <sub>4</sub> Cl + H <sub>2</sub> O at 30°.	(Schreinemakers, 1909.)
"	+	" + KCl + H <sub>2</sub> O at 40° and 60°.	( " and de Baat, 1914.)
"	+	" + NaCl + H <sub>2</sub> O at 30°.	( " and de Baat, 1908-09.)
"	+	BaO + Na <sub>2</sub> O + H <sub>2</sub> O at 30°.	(Schreinemakers, 1910b.)
"	+	Ba(NO <sub>3</sub> ) <sub>2</sub> + NaNO <sub>3</sub> + NaCl + H <sub>2</sub> O at 30°.	(Coppadoro, 1913.)
"	+	HCl + NaCl + H <sub>2</sub> O at 30°.	(Schreinemakers, 1909-10, 1910b.)



# BARIUM CHLORIDE

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## SOLUBILITY OF BARIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID:

At 0°. (Engel, 1888.)			At 30°. (Masson, 1911, 1912-13; Schreinemakers, 1909-10.)		
Sp. Gr.	Gms. per 100 Gms. Sat. Sol.		Sp. Gr.	Gms. per 100 Gms. Sat. Sol.	
Sat. Sol.	HCl.	BaCl <sub>2</sub> .	Sat. Sol.	HCl.	BaCl <sub>2</sub> .
1.250	0	24.07	1.3056	0	27.84
1.242	0.32	23.31	1.2651	1.36	24.02
1.228	0.83	22.11	1.2147	3.32	19.20
1.210	1.51	20.14	1.1789	5.01	15.2
1.143	4.58	12.76	1.1419	7.13	11.1
1.118	6.13	9.37	1.1068	10	5.8
1.099	7.55	6.33	1.0880	13.43	2.4
1.079	10.81	2.64	1.0895	16.92	0.38
1.088	16.92	0.28	1.1024	20.62	0
			1.1609	32.18	0

The results of Schreinemakers show that at 37.34% HCl the barium chloride hydrate is converted into monohydrate.

Less than 1 part of BaCl<sub>2</sub> is soluble in 20,000 parts of concentrated HCl and 120,000 parts of conc. HCl containing  $\frac{1}{2}$  volume of ether. (Mar, 189)

## SOLUBILITY OF BARIUM CHLORIDE IN AQUEOUS SOLUTIONS OF MERCURIC CHLORIDE:

At 0° (Schreinemakers, 1910.)			At 30° (Schreinemakers, 1910.)		
Gms. per 100 Gms.	Gms. Sat. Sol.		Gms. per 100 Gms.	Gms. Sat. Sol.	
	HgCl <sub>2</sub> .	BaCl <sub>2</sub> .		HgCl <sub>2</sub> .	BaCl <sub>2</sub> .
0	23.70		0	27.77	BaCl <sub>2</sub> ·2H <sub>2</sub> O
14.25	24		24.90	27.56	"
36.20	24.89		12.98	26.99	"
46.08	24.05	BaCl <sub>2</sub> ·3HgCl <sub>2</sub> ·6H <sub>2</sub> O + BaCl <sub>2</sub> ·2H <sub>2</sub> O	34.57	26.69	"
46.59	23.28	BaCl <sub>2</sub> ·3HgCl <sub>2</sub> ·6H <sub>2</sub> O	46.50	25.22	"
47.78	21.05	"	55.22	23.17	" + HgC
48.46	20.67	" + HgCl <sub>2</sub>	48.97	17.87	HgCl <sub>2</sub>
44.33	18.50	HgCl <sub>2</sub>	41.30	14.26	"
29	11.59	"	27.62	8.41	"
16.36	6.11	"	14.19	2.65	"
3.95	0	"	7.67	0	"

## SOLUBILITY OF MIXTURES OF BARIUM CHLORIDE AND MERCURIC CHLORIDE IN WATER.

(Foote and Bristol — Am. Ch. J. 32, 248, '04.)

t°.	Gms. per 100 Gms. Solution.		Solid Phase.	t°.	Gms. per 100 Gms. Solution.		Solid Phase.
	BaCl <sub>2</sub> .	HgCl <sub>2</sub> .			BaCl <sub>2</sub> .	HgCl <sub>2</sub> .	
10.4	23.58	50.54	{ BaCl <sub>2</sub> ·2H <sub>2</sub> O + HgCl <sub>2</sub> .	10.4	22.10	51.66	{ Double Salt BaCl <sub>2</sub> ·3HgCl <sub>2</sub> ·6H <sub>2</sub> O
10.4	23.44	50.74	{ Double Salt BaCl <sub>2</sub> ·3HgCl <sub>2</sub> ·6H <sub>2</sub> O.	10.4	21.64	51.74	{ BaCl <sub>2</sub> ·2H <sub>2</sub> O + HgC
10.4	22.58	51.23		25	23.02	54.83	
10.4	22.48	51.41					

## SOLUBILITY OF MIXTURES OF BARIUM CHLORIDE AND SODIUM CHLORIDE IN WATER:

At 30°.

(Schreinemakers and de Baat, 1908-09.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 G Sat. Sol.	
BaCl <sub>2</sub> .	NaCl.		BaCl <sub>2</sub> .	NaCl.			BaCl <sub>2</sub> .	NaCl.
0	26.47	NaCl	12.25	13.39	BaCl <sub>2</sub> ·2H <sub>2</sub> O	20	2.9	25
2.28	25.28	"	15.83	10.06	"	40	4.5	23
3.80	23.77	" + BaCl <sub>2</sub> ·2H <sub>2</sub> O	20.93	5.39	"	60	6.8	23.
5.76	20.25	BaCl <sub>2</sub> ·2H <sub>2</sub> O	24.24	2.76	"	80	9.4	22.
8.19	17.89	"	27.60	0	"	100	11.8	22

At Varying Temp

(Precht and Wittgen, 181  
Rüddorf, 1885.)



SOLUBILITY OF MIXTURES OF BARIUM CHLORIDE AND POTASSIUM CHLORIDE  
IN WATER. (Foote, 1904.)

100 gms. saturated solution contain 13.83 gms.  $\text{BaCl}_2$  + 18.97 gms.  $\text{KCl}$  at  $25^\circ$ .

Fusion-point curves (solubility, see footnote, p. 1) are given for the following mixtures:

$\text{BaCl}_2 + \text{BaCO}_3$	(Sackur, 1911-12.)
" + $\text{BaCrO}_4$	"
" + $\text{BaO}$	(Sackur, 1911-12, Arndt, 1907.)
" + $\text{BaSO}_4$	(Sackur, 1911-12, Ruff and Plato, 1903.)
" + $\text{BaF}_2$	(Botta, 1911; Ruff and Plato, 1903; Plato, 1907.)
" + $\text{BaI}_2$	(Ruff and Plato, 1903.)
" + $\text{CdCl}_2$	(Sandonini, 1911, 1914; Ruff and Plato, 1903.)
" + $\text{CaCl}_2$	(Sandonini, 1911, 1914; Ruff and Plato, 1903; Schaefer, 1914.)
" + $\text{CuCl}_2$	(Sandonini, 1914.)
" + $\text{PbCl}_2$	(Sandonini, 1911, 1914; Ruff and Plato, 1903.)
" + $\text{LiCl}$	(Sandonini, 1913, 1914.)
" + $\text{MgCl}_2$	(Sandonini, 1912, 1914.)
" + $\text{MnCl}_2$	(Sandonini, 1912, 1914; Ruff and Plato, 1903.)
" + $\text{KCl}$	(Sandonini, 1911; Ruff and Plato, 1903; Vortisch, 1914.)
" + $\text{NaCl}$	(Sackur, 1911-12; Ruff and Plato, 1903; Le Chatelier, 1894; Vortisch, 1914.)
" + $\text{NaCl} + \text{KCl}$	(Vortisch, 1914 (a); Gemsky.)
" + $\text{SrCl}_2$	(Sandonini, 1911, 1914; Ruff and Plato, 1903; Vortisch, 1914.)
" + $\text{ZnCl}_2$	(Sandonini, 1912 a, 1914.)
" + $\text{TlCl}$	(Korring, 1914.)

SOLUBILITY OF BARIUM CHLORIDE IN AQUEOUS ETHYL ALCOHOL SOLUTIONS.

At $15^\circ$ . (Schiff, 1861; Rehner, 1897.)		At $30^\circ$ . (Schreinemakers and Messink, 1910.)		At $60^\circ$ .	
Wt. % $\text{C}_2\text{H}_5\text{OH}$	Gms. $\text{BaCl}_2$ per 100 Gms. Solvent.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
		$\text{C}_2\text{H}_5\text{OH}$	$\text{BaCl}_2$	$\text{C}_2\text{H}_5\text{OH}$	$\text{BaCl}_2$
10	31.1	0	27.95 $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$	0	31.57 $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$
20	21.9	32.67	10.63 "	16.68	20.16 "
30	14.7	50.16	5.68 "	34.10	13.21 "
40	10.2	60.72	2.23 "	66.02	2.82 "
50	3.5	92.53	0.05 "	88.55	0.25 "
60	0.5	94.73	0.06 " + $\text{BaCl}_2 \cdot \text{H}_2\text{O}$	90.25	0.09 " + $\text{BaCl}_2 \cdot \text{H}_2\text{O}$
97	0.014	97.14	$\text{BaCl}_2 \cdot \text{H}_2\text{O}$	93.95	...
		98.17	" + $\text{BaCl}_2$		
		99.41	$\text{BaCl}_2$		

100 gms. methyl alcohol dissolve 2.18 gms.  $\text{BaCl}_2$  at  $15.5^\circ$  and 7.3 gms.  $\text{BaCl}_2$ .  
2  $\text{H}_2\text{O}$  at  $6^\circ$ . (de Bruyn, 1892.)

100 gms. glycerol dissolve 9.73 gms.  $\text{BaCl}_2$  at  $15^\circ$ - $16^\circ$ . (Ossendowski, 1907.)

100 cc. anhydrous hydrazine dissolve 31 gms.  $\text{BaCl}_2$  at room temp.

(Welsh and Broderson, 1915.)

100 gms. 95% formic acid dissolve 7.3 gms.  $\text{BaCl}_2$  at  $19^\circ$ . (Aschan, 1913.)

One liter sat. sol. in nitrobenzene contains 0.167 gm.  $\text{BaCl}_2$  at  $20^\circ$ , 0.33 gm. at  
 $50^\circ$  and 0.40 gm. at  $100^\circ$ . (Lloyd, 1918.)

Data for the system  $\text{BaCl}_2 + \text{Triethylamine} + \text{H}_2\text{O}$  are given by Timmermans  
(1907).

SOLUBILITY OF MIXTURES OF BARIUM CHLORIDE AND GLYCINE IN WATER  
AT  $20^\circ$ . (Pfeiffer and Modelski, 1912.)

Gms. per 100 cc. Sat. Sol.	Solid Phase.	
$\text{NH}_2\text{CH}_2\text{COOH}$	$\text{BaCl}_2$	
5.5	37	$\text{BaCl}_2 \cdot 2\text{H}_2\text{O} + \text{BaCl}_2 \cdot 2\text{NH}_2\text{CH}_2\text{COOH} \cdot \text{H}_2\text{O}$
20	16	$\text{NH}_2\text{CH}_2\text{COOH} + \text{BaCl}_2 \cdot 2\text{NH}_2\text{CH}_2\text{COOH} \cdot \text{H}_2\text{O}$



**BARIUM CHROMATE**

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**BARIUM CHROMATE**  $\text{BaCrO}_4$ .

## SOLUBILITY OF BARIUM CHROMATE IN WATER.

One liter of sat. solution contains 0.002 gm. of the salt at 0°; 0.0028 gm. at 10°; 0.0037 gm. at 20° and 0.0046 gm. at 30°. (Kohlrausch, 1908.)

Results higher than the above are given by Schweitzer, 1890, as follows: One liter of aqueous solution saturated at room temp. contains 0.01 gm.  $\text{BaCrO}_4$ ; if ignited barium chromate is used, only 0.0062 gm. dissolves.

One liter sat. sol. contains 0.043 gm. of the salt at boiling point. (Mescherzaki, 1881.)

Fresenius (1890) gives the following: 1 liter of sat. sol. at room temp. contains 0.02 gm. of the salt, the solvent being 1.5% sol. of  $\text{CH}_3\text{CO}_2\text{NH}_4$  and 0.022 gms. when the solvent is 0.5% sol. of  $\text{NH}_4\text{NO}_3$ .

One liter of 45% aq. ethyl alcohol solution dissolves 0.000022 gm. at room temp. (Guerini, 1912.)

**BARIUM CINNAMATES.**

## SOLUBILITY OF BARIUM CINNAMATES IN WATER, METHYL ALCOHOL AND ACETONE.

Compound.	Formula.	t°.	Solvent.	Gms. Anhydrous Salt per 100 Gms. Sat. Sol.	Authority.
Barium Cinnamate	$\text{Ba}(\text{C}_9\text{H}_7\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$	15	$\text{H}_2\text{O}$	0.726	(Tarugi and Checchi, 1901.)
"	"	100	"	2.27	"
" Allocinnamate	$\text{Ba}(\text{C}_9\text{H}_7\text{O}_2)_2 \cdot \text{H}_2\text{O}$	19	$\text{CH}_3\text{OH}$	15.8	(Liebermann, 1903.)
"	"	12	"	15.4	(Michael and Garner, 1903.)
"	$\text{Ba}(\text{C}_9\text{H}_7\text{O}_2)_2 \cdot 3\text{H}_2\text{O}$	20	"	2.56	(Michael, 1901.)
"	"	20	$(\text{CH}_3)_2\text{CO}$	0.80	"
"	"	20	$\text{H}_2\text{O}$	6	"
" Hydrocinnamate	$\text{Ba}(\text{C}_9\text{H}_7\text{O}_2)_2 \cdot 2\text{H}_2\text{O}$	27	"	2.9	"
"	"	25	$\text{CH}_3\text{OH}$	0.1	"
"	"	16	"	9.7	(Michael and Garner, 1903.)
" Isocinnamate	"	20	"	70	(Michael, 1901.)
"	"	20	$(\text{CH}_3)_2\text{CO}$	20	"
"	"	20	$\text{H}_2\text{O}$	17	"

**BARIUM CITRATE**  $\text{Ba}_3(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 7\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER AND IN ALCOHOL.

100 grams water dissolve 0.0406 gram  $\text{Ba}_3(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 7\text{H}_2\text{O}$  at 18° and 0.0572 gm. at 25°.

100 grams 95% alcohol dissolve 0.0044 gram  $\text{Ba}_3(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 7\text{H}_2\text{O}$  at 18°, and 0.0058 gm. at 25°.

(Partheil and Hübner — Archiv. Pharm. 241, 413, '03.)

**BARIUM CYANIDE**  $\text{Ba}(\text{CN})_2$ .

## SOLUBILITY IN WATER AND IN ALCOHOL AT 14°.

(Joannis — Ann. chim. phys. [5] 26, 489, '82.)

100 parts water dissolve 80 parts  $\text{Ba}(\text{CN})_2$ .

100 parts 70% alcohol dissolve 18 parts  $\text{Ba}(\text{CN})_2$ .

**BARIUM FERROCYANIDE AND BARIUM POTASSIUM FERROCYANIDE.**

(Wyrouboff — Ann. chim. phys. [4] 16, 292, '69.)

100 parts water dissolve 0.1 part  $\text{Ba}_2\text{Fe}(\text{CN})_6 \cdot 6\text{H}_2\text{O}$  at 15°, and 1.0 part at 75°.

100 parts water dissolve 0.33 part  $\text{BaK}_2\text{Fe}(\text{CN})_6 \cdot 5\text{H}_2\text{O}$  at ord. temp.

**BARIUM FLUORIDE**  $\text{BaF}_2$ .

## SOLUBILITY IN WATER.

(Kohlrausch, 1908.)

One liter sat. sol. contains 1.586 gms. of the salt at 10°; 1.597 gms. at 15°; 1.607 gms. at 20°; 1.614 gms. at 25° and 1.620 gms. at 30°.

Freezing-point curves are given for mixtures of  $\text{BaF}_2 + \text{KF}$  by Puschin and Baskow (1913), and for  $\text{BaF}_2 + \text{BaI}_2$  by Ruff and Plato (1903).



**BARIUM FORMATE**  $\text{Ba}(\text{HCOO})_2$ .

SOLUBILITY IN WATER. (Stanley, 1904. See also Krasnicki, 1887.)

t°.	Gms. $\text{Ba}(\text{HCOO})_2$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{Ba}(\text{HCOO})_2$ per 100 Gms. Sat. Sol.
0	23.24	40	25
10	23.22	50	25.9
20	23.65	60	26.9
25	23.9	80	29.3
30	24.2	100	32.8

**BARIUM HYDROXIDE**  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$ .SOLUBILITY IN WATER. SOLID PHASE  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$ .

(Rosenthal and Rühlmann — Jahresber. Chem. 314, '70.)

t°.	Gms. $\text{Ba}(\text{OH})_2$ per 100 Gms. Water.	Solution.	t°.	Gms. $\text{Ba}(\text{OH})_2$ per 100 Gms. Water.	Solution.
0	1.67	1.65	30	5.59	5.29
5	1.95	1.92	40	8.22	7.60
10	2.48	2.42	50	13.12	11.61
15	3.23	3.13	60	20.94	17.32
20	3.89	3.74	75	63.51	38.85
25	4.68	4.47	80	101.40	50.35

Data are given by Sill (1916), for the influence of pressures up to 490 kgs. per sq. cm. on the solubility of  $\text{Ba}(\text{OH})_2 \cdot 8\text{H}_2\text{O}$  in  $\text{H}_2\text{O}$  at 25°.

SOLUBILITY OF BARIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF BARIUM NITRATE AT 25° AND VICE VERSA. (Parsons and Carson, 1910.)

Sp. Gr. Sat. Sol.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	Sp. Gr. Sat. Sol.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
1.0512	4.29	0	1.1371	4.93	10.21
1.0651	4.35	1.88	1.1448	5.02	11.48
1.0790	4.48	3.47	1.1210	3.22	11.04
1.0975	4.40	5.66	1.1002	1.55	10.66
1.1220	4.72	7.55	1.0797	0	10.30

SOLUBILITY OF BARIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF ALKALI CHLORIDES AT 25°. (Herz, 1910.)

In Lithium Chloride.		In Potassium Chloride.		In Rubidium Chloride.		In Sodium Chloride.	
Gms. per 100 cc. Sat. Sol.		Gms. per 100 cc. Sat. Sol.		Gms. per 100 cc. Sat. Sol.		Gms. per 100 cc. Sat. Sol.	
$\text{LiCl}$	$\text{Ba}(\text{OH})_2$	$\text{KCl}$	$\text{Ba}(\text{OH})_2$	$\text{RbCl}$	$\text{Ba}(\text{OH})_2$	$\text{NaCl}$	$\text{Ba}(\text{OH})_2$
9.75	11.45	25.95	5.93	15.11	5.55	16.51	6.91
6.02	8.03	13.05	5.66	0	4.76	8.37	5.99
3.18	6.39	8.60	5.53	...	...	4.27	5.40
0	4.76	0	4.76	...	...	0	4.76

SOLUBILITY OF BARIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF SODIUM HYDROXIDE AT 30°. (Schreinemakers, 1909-10.)

Gms. per 100 Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
$\text{BaO}$		$\text{BaO}$	
4.99	0	1.84	26.14
1.29	4.78	1.75	27.72
0.89	6.43	1.58	28.43
0.57	9.63	1.34	29.24
0.53	11.62	0.82	32.12
0.47	17.87	0.59	34.72
1.06	23.28	0.57	41.09
1.87	24.63	0	+42



## BARIUM HYDROXIDE

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### SOLUBILITY OF BARIUM HYDROXIDE IN AQUEOUS ACETONE AT 25°.

(Hetz and Knoch—Z. anorg. Chem. 41, 321, '04.)

Sp. Gr. of Solutions.	Vol. % Acetone.	Ba(OH) <sub>2</sub> per 100 cc. Sat. Solution.		Gms. Ba(OH) <sub>2</sub> per 100 Gms. Solution.
		Millimols.	Grams.	
1.0479	0	55.08	4.722	4.506
1.0168	10	31.84	2.730	2.686
0.9927	20	17.79	1.525	1.536
0.9763	30	9.10	0.779	0.798
0.9561	40	4.75	0.407	0.426
0.9398	50	1.54	0.132	0.141
0.9179	60	0.48	0.041	0.045
0.8956	70	0.08	0.007	0.018

Data for the systems Ba(OH)<sub>2</sub> + Phenol + H<sub>2</sub>O at 25° and Ba(OH)<sub>2</sub> + Resorcinol + H<sub>2</sub>O at 30° are given by van Meurs (1916).

## BARIUM IODATE Ba(IO<sub>3</sub>)<sub>2</sub>·H<sub>2</sub>O.

### SOLUBILITY IN WATER. (Trautz and Anschütz, 1906.)

t°.	Gms. Ba(IO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Solution	t°.	Gms. Ba(IO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Solution.	t°.	Gms. Ba(IO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Solution
- 0.046	0.008	30	0.031	70	0.093
+ 10	0.014	40	0.041	80	0.115
20	0.022	50	0.056	90	0.141
25	0.028	60	0.074	100	0.197

One liter sat. aqueous solution contains 0.3845 gm. Ba(IO<sub>3</sub>)<sub>2</sub> at 25°.

(Harkins and Winninghoff, 1911.)

At room temperature Hill and Zink (1909), found 0.284 gm. Ba(IO<sub>3</sub>)<sub>2</sub> per liter sat. aqueous solution.

### SOLUBILITY OF BARIUM IODATE IN AQUEOUS SALT SOLUTIONS AT 25°.

(Harkins and Winninghoff, 1911.)

Added Salt.	Mols. Salt per Liter.	Gms. Ba(IO <sub>3</sub> ) <sub>2</sub> per Liter.	Added Salt.	Mols. Salt per Liter.	Gms. Ba(IO <sub>3</sub> ) <sub>2</sub> per Liter.	Added Salt.	Mols. Salt per Liter.	Gms. Ba(IO <sub>3</sub> ) <sub>2</sub> per Liter.
Ba(NO <sub>3</sub> ) <sub>2</sub>	0.001	0.331	Ba(NO <sub>3</sub> ) <sub>2</sub>	0.100	0.148	KNO <sub>3</sub>	0.200	0.777
"	0.002	0.294	"	0.200	0.136	KIO <sub>3</sub>	0.000106	0.368
"	0.005	0.237	KNO <sub>3</sub>	0.002	0.396	"	0.000530	0.303
"	0.020	0.164	"	0.010	0.445	"	0.001061	0.229
"	0.050	0.149	"	0.050	0.643			

100 cc. conc. ammonia (Sp. Gr. 0.90) dissolve 0.0199 gm. Ba(IO<sub>3</sub>)<sub>2</sub> at room temp.

(Hill and Zink, 1909)

100 cc. 95% ethyl alcohol dissolve 0.0011 gm. Ba(IO<sub>3</sub>)<sub>2</sub> at room temp.

(Hill and Zink, 1909)

## BARIUM IODIDE BaI<sub>2</sub>.

### SOLUBILITY IN WATER.

(Kremers—Pogg. Ann. 103, 66, 1858; Etard—Ann. chim. phys. [7] 2, 544, '94.)

t°.	Gms. BaI <sub>2</sub> per 100 Gms. Water. Solution.		Solid Phase.	t°.	Gms. BaI <sub>2</sub> per 100 Gms. Water. Solution.		Solid Phase.
- 20	143.9	59.0	BaI <sub>2</sub> ·6 H <sub>2</sub> O	40	231.9	69.8	BaI <sub>2</sub> ·2 H <sub>2</sub> O
0	170.2	63.0	"	60	247.3	71.2	"
+ 10	185.7	65.0	"	80	261.0	72.3	"
20	203.1	67.0	"	100	271.7	73.1	"
25	212.5	68.0	"	120	281.7	73.8	"
30	219.6	68.7	"	160	294.8	74.6	"

Sp. Gr. of sat. solution at 19°.5 = 2.24.

100 gms. 95% HCOOH dissolve 75 gms. BaI<sub>2</sub> at 20.2°.

(Aschan, 1911)

100 gms. 97% ethyl alcohol dissolve 1.07 gms. BaI<sub>2</sub>·2H<sub>2</sub>O at 15°.

(Rohland, 189)

Data for the system BaI<sub>2</sub> + BaO + H<sub>2</sub>O at 25° are given by Milikau (1916).



**BARIUM PerIODIDE**  $\text{BaI}_2$ .

Data for the formation of barium periodide in aqueous solutions at  $25^\circ$  are given by Herz and Bulla (1911). (See reference calcium perbromide, p. 186.)

**BARIUM IODOMERCURATE.**

A saturated solution of  $\text{BaI}_2$  and  $\text{HgI}_2$  in water at  $23.5^\circ$  was found by Duboin (1906) to have the composition  $\text{BaI}_2 \cdot 1.33\text{HgI}_2 \cdot 7.76\text{H}_2\text{O}$ ,  $d = 2.76$ .

**BARIUM MALATE**  $\text{BaC}_4\text{H}_4\text{O}_6$ .

## SOLUBILITY IN WATER.

(Cantoni and Basadonna — Bull. soc. chim. [3] 35, 731, '06.)

t°.	Gms. $\text{BaC}_4\text{H}_4\text{O}_6$ per 100 cc. Sol.	t°.	Gms. $\text{BaC}_4\text{H}_4\text{O}_6$ per 100 cc. Sol.	t°.	Gms. $\text{BaC}_4\text{H}_4\text{O}_6$ per 100 cc. Sol.
20	0.883	35	0.895	60	1.011
25	0.901	40	0.896	70	1.041
30	0.903	50	0.942	80	1.044

## SOLUBILITY IN WATER AND IN ALCOHOL.

(Partheil and Hübner — Archiv. Pharm. 241, 413, '03.)

100 grams water dissolve 1.24 gms.  $\text{BaC}_4\text{H}_4\text{O}_6$  at  $18^\circ$ , and 1.3631 gms. at  $25^\circ$ .

100 grams 95% alcohol dissolve 0.0038 gms.  $\text{BaC}_4\text{H}_4\text{O}_6$  at  $18^\circ$ , and 0.0039 gm. at  $25^\circ$ .

**BARIUM MALONATE**  $\text{BaC}_2\text{H}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Miczynski — Monatsch. Chem. 7, 263, '86.)

t°.	Gms. $\text{BaC}_2\text{H}_2\text{O}_4$ per 100 Gms.		t°.	Gms. $\text{BaC}_2\text{H}_2\text{O}_4$ per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	0.143	0.143	50	0.287	0.285
10	0.179	0.179	60	0.304	0.303
20	0.212	0.211	70	0.317	0.316
30	0.241	0.240	80	0.326	0.325
40	0.266	0.265			

Results slightly higher than the above, from  $0^\circ$ – $50^\circ$  are given by Cantoni and Diotallevi (1905).

**BARIUM MOLYBDATE**  $\text{BaMoO}_4$ .

100 parts water dissolve 0.0058 part  $\text{BaMoO}_4$  at  $23^\circ$ . (Smith and Bradbury, 1891.)

**BARIUM NITRATE**  $\text{Ba}(\text{NO}_3)_2$ .

## SOLUBILITY IN WATER.

(Meiser; Gay Lussac; Etard — Ann. chim. phys. [7] 2, 528, 94; Euler — Z. physik. Chem. 49, 315, '04.)

t°.	Gms. $\text{Ba}(\text{NO}_3)_2$ per 100 Gms.		t°.	Gms. $\text{Ba}(\text{NO}_3)_2$ per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	5.0	4.8	80	27.0	21.3
10	7.0	6.5	100	34.2	25.5
20	9.2	8.4	120	42.0	29.6
25	10.4	9.4	140	50.0	33.3
30	11.6	10.6	160	58.0	36.7
40	14.2	12.4	180	67.0	40.1
50	17.1	14.6	200	76.0	43.2
60	20.3	16.9	215	84.5	45.8

Results from  $0^\circ$ – $35^\circ$  differing from the above are given by Vogel (1903).

100 gms. sat. aqueous solution contains 4.74 gms.  $\text{Ba}(\text{NO}_3)_2$  at  $0^\circ$ . (Coppadoro, 1911.)



# BARIUM NITRATE

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## SOLUBILITY OF MIXTURES OF BARIUM NITRATE AND LEAD NITRATE IN AT 25°. (Fock, 1897; Euler, 1904.)

Sp. Gr. of Solution.	In Solution.					In So M Ba
	Gms. per Liter.		Mg. Mols. per Liter.		Mol. % Ba(NO <sub>3</sub> ) <sub>2</sub> .	
	Ba(NO <sub>3</sub> ) <sub>2</sub> .	Pb(NO <sub>3</sub> ) <sub>2</sub> .	Ba(NO <sub>3</sub> ) <sub>2</sub> .	Pb(NO <sub>3</sub> ) <sub>2</sub> .		
I. 079	102.2	0	391.0	0	100	10
I. 088	54.9	17.63	210.1	53.3	79.78	9
I. 108	86.5	49.80	330.7	150.7	68.70	9
I. 119	79.7	68.10	304.9	205.7	59.69	9
I. 140	77.0	97.20	294.4	293.6	50.09	9
I. 163	69.8	130.7	266.8	395.0	40.31	9
I. 198	66.0	177.3	252.5	535.6	32.03	9
I. 252	57.5	247.7	222.6	748.5	22.91	8
I. 294	25.9	334.3	99.2	1010.3	8.11	7
I. 376	28.8	429.7	110.3	1298.0	7.77	3
I. 450	...	553.8	0.0	1673.0	0.0	

Tables of results are also given for 15°, 30°, and 47°.

## SOLUBILITY OF MIXTURES OF BARIUM NITRATE AND POTASSIUM NITRATE IN (Findlay, Morgan and Morris, 1914; Foote, 1904.)

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.	
	Ba(NO <sub>3</sub> ) <sub>2</sub> .	KNO <sub>3</sub> .			Ba(NO <sub>3</sub> ) <sub>2</sub> .	KNO <sub>3</sub> .
9.1	6.25	0	a	25*	6.62	14.89
9.1	4.20	8.15	a+2b.a	25	5.49	16.30
9.1	1.98	12.02	2b.a	25	3.04	21.99
9.1	0.98	16.80	b+2b.a	25	2.04	27.76
9.1	0	16.76	b	35	11.39	0
21.1	8.46	0	a	35	8.18	12.99
21.1	7.47	2.12	"	35	8.08	17.48
21.1	6.35	5.98	"	35	8.42	19.75
21.1	6.06	8.47	"	35	5.85	24
21.1	5.98	13.24	a+2b.a	35	5.02	26.05
21.1	3.35	18.24	2b.a	35	3.02	34.87
21.1	2.30	21.47	"	35	1.77	34.98
21.1	1.76	24.86	b+2b.a	35	0	35.01
21.1	0	24.77	b			

\* Results by Foote.

a = Ba(NO<sub>3</sub>)<sub>2</sub>, 2b.a = 2KNO<sub>3</sub>.Ba(NO<sub>3</sub>)<sub>2</sub>, b = KNO<sub>3</sub>.

## SOLUBILITY OF MIXTURES OF BARIUM NITRATE AND SODIUM NITRATE IN (Coppadoro, at 0°, 1912; at 30°, 1913.)

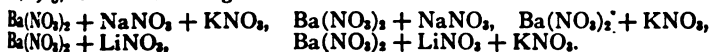
Results at 0°.			Results at 30°.		
Gms. per 100 Gms. Sat. Sol.	Ba(NO <sub>3</sub> ) <sub>2</sub> .	NaNO <sub>3</sub> .	Gms. per 100 Gms. Sat. Sol.	Ba(NO <sub>3</sub> ) <sub>2</sub> .	NaNO <sub>3</sub> .
4.33	0.41		10.33	0	
3.34	1.68		8.58	2.33	
2.50	3.54		5.28	7.09	
1.60	8.02		3.89	12.07	
1.56	12.71		3.54	14.41	
1.53	20.24		3.20	17.87	
1.56	27.74		3.07	19.06	
1.55	30.81		2.81	23.55	
1.49	35.83		2.27	41.22	
1.55	40.85	98 % Ba(NO <sub>3</sub> ) <sub>2</sub> + 2 % NaNO <sub>3</sub>	2.11	48.22	Ba(NO <sub>3</sub> ) <sub>2</sub>
1.55	41.30	26 % " + 73.8% "	1	48.50	N
1.54	42.06	2.6% " + 97.4% "	0	49.16	
0.51	41.68	0 % " + 100 % "			



**SOLUBILITY OF BARIUM NITRATE IN AQUEOUS SOLUTIONS OF NITRIC ACID AT 30°.**  
(Masson, 1911.)

Sp. Gr.	Gms. per 100 cc. Sat. Sol.		Sp. Gr.	Gms. per 100 cc. Sat. Sol.	
	HNO <sub>3</sub> .	Ba(NO <sub>3</sub> ) <sub>2</sub> .		HNO <sub>3</sub> .	Ba(NO <sub>3</sub> ) <sub>2</sub> .
1.0891	0	54.31	1.0633	78.54	16.66
1.0811	8.303	30.50	1.0668	98.40	15.88
...	15.72	27.73	1.0783	125.9	14.99
1.0663	31.49	22.76	1.1050	188.6	14.11
1.0619	47.18	19.71	1.1341	251.6	13.75
1.0609	63	17.84	1.1645	315.7	13.52

Fusion-point curves (solubility, see footnote, p. 1) are given by Harkins and Clarke, 1915, for the following mixtures:



**SOLUBILITY OF BARIUM NITRATE IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°.**  
(D'Ans and Siegler, 1913.)

Gms. C <sub>2</sub> H <sub>5</sub> OH per 100 Gms. Solvent.	Gms. per 100 Gms. Sat. Sol.		Gms. C <sub>2</sub> H <sub>5</sub> OH per 100 Gms. Solvent.	Gms. per 100 Gms. Sat. Sol.	
	C <sub>2</sub> H <sub>5</sub> OH.	Ba(NO <sub>3</sub> ) <sub>2</sub> .		C <sub>2</sub> H <sub>5</sub> OH.	Ba(NO <sub>3</sub> ) <sub>2</sub> .
0	0	9.55	58	57	1.85
10.25	9.5	7.63	78.7	78.2	0.62
18.6	17.5	6.02	90.1	89.9	0.18
25.05	23.7	5.25	99.4	99.39	0.005
40.2	38.3	3.53			

Data are also given by Vogel (1903), but as the results are given in gms. per 100 cc. and densities are omitted, no exact comparison can be made with the above.

**SOLUBILITY OF BARIUM NITRATE IN AQUEOUS PHENOL SOLUTIONS AT 25°.**

(Rothmund and Wilsmore — Z. physik. Chem. 40, 620, '02.)

G. Mols. per Liter.		Gms. per Liter.		G. Mols. per Liter.		Gms. per Liter.	
C <sub>6</sub> H <sub>5</sub> OH.	Ba(NO <sub>3</sub> ) <sub>2</sub> .	C <sub>6</sub> H <sub>5</sub> OH.	Ba(NO <sub>3</sub> ) <sub>2</sub> .	C <sub>6</sub> H <sub>5</sub> OH.	Ba(NO <sub>3</sub> ) <sub>2</sub> .	C <sub>6</sub> H <sub>5</sub> OH.	Ba(NO <sub>3</sub> ) <sub>2</sub> .
0.000	0.3835	0.0	100.2	0.310	0.3492	29.12	91.31
0.045	0.3785	4.23	98.97	0.401	0.3400	37.73	88.90
0.082	0.3746	7.71	97.95	0.501	0.3299	47.11	86.26
0.146	0.3664	13.73	95.81	0.728 (sat.)	0.3098	68.45	81.00

Data for the above system are also given by Timmermans (1907).

100 gms. hydroxylamine dissolve 11.4 gms. Ba(NO<sub>3</sub>)<sub>2</sub> at 17°–18°. (de Bruyn, 1892.)

100 cc. anhydrous hydrazine dissolve 3 gms. Ba(NO<sub>3</sub>)<sub>2</sub> at room temp.

100 gms. methyl alcohol dissolve 0.5 gm. Ba(NO<sub>3</sub>)<sub>2</sub> at 25°. (Welsh and Brodersen, 1915.)

100 gms. acetone dissolve 0.005 gm. Ba(NO<sub>3</sub>)<sub>2</sub> at 25°. (D'Ans and Siegler, 1913.)

**BARIUM NITRITE Ba(NO<sub>2</sub>)<sub>2</sub>·H<sub>2</sub>O.**

**SOLUBILITY IN WATER.**

(Oswald, 1914; see also, Vogel, 1903.)

t°.	Gms. Ba(NO <sub>2</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. Ba(NO <sub>2</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-1.7	9.2	Ice	20	40.3	Ba(NO <sub>2</sub> ) <sub>2</sub> ·H <sub>2</sub> O
-3.2	19.5	"	43	50.3	"
-5.8	33.1	"	61	58.6	"
-6.5	34.5	" + Ba(NO <sub>2</sub> ) <sub>2</sub> ·H <sub>2</sub> O	80	67.3	"
-4.3	34.9	Ba(NO <sub>2</sub> ) <sub>2</sub> ·H <sub>2</sub> O	92	71.7	"
+17	40*	"	110	82	"

\* d of the sat. solution = 1.4897.



# BARIUM NITRITE

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## SOLUBILITY OF MIXTURES OF BARIUM NITRITE AND SILVER NITRITE IN WATER AT 13.5°. (Oswald, 1914.)

Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.
Ba(NO <sub>2</sub> ) <sub>2</sub> .	AgNO <sub>3</sub> .	
64	10.2	AgNO <sub>2</sub> +BaAg <sub>2</sub> (NO <sub>2</sub> ) <sub>4</sub> .H <sub>2</sub> O
75.6	9.5	Ba(NO <sub>2</sub> ) <sub>2</sub> +BaAg <sub>2</sub> (NO <sub>2</sub> ) <sub>4</sub> .

## SOLUBILITY OF BARIUM NITRITE IN AQUEOUS ALCOHOL SOLUTION 19.5°-20.5°. (Vogel, 1903.)

% alcohol in solvent:	10	20	30	40	50	60	70
Gms. Ba(NO <sub>2</sub> ) <sub>2</sub> .H <sub>2</sub> O } per 100 cc. sat. sol. }	49.3	29.3	18.4	13.3	9.1	4.8	2.7

# BARIUM OXALATE BaC<sub>2</sub>O<sub>4</sub>.

## SOLUBILITY OF THE THREE HYDRATES IN WATER.

(Groschuff — Ber. 34, 3318, '01.)

t°.	BaC <sub>2</sub> O <sub>4</sub> . $\frac{3}{2}$ H <sub>2</sub> O.		BaC <sub>2</sub> O <sub>4</sub> .2H <sub>2</sub> O.		BaC <sub>2</sub> O <sub>4</sub> .H <sub>2</sub> O.	
	Gms. BaC <sub>2</sub> O <sub>4</sub> per 1000 g. Sol.	G. M. BaC <sub>2</sub> O <sub>4</sub> per 100 Mol. H <sub>2</sub> O.	Gms. BaC <sub>2</sub> O <sub>4</sub> per 1000 g. Sol.	G. M. BaC <sub>2</sub> O <sub>4</sub> per 100 G. M. H <sub>2</sub> O.	Gms. BaC <sub>2</sub> O <sub>4</sub> per 1000 g. Sol.	G. M. BaC <sub>2</sub> O <sub>4</sub> per 100 G. M. H <sub>2</sub> O.
0	0.058	0.00046	0.053	0.00042	0.089	0.00071
9.5	0.082	0.00066	...	...	...	...
18	0.112	0.00090	0.089	0.00071	0.124	0.00097
30	0.170	0.00136	0.121	0.00097	0.140	0.00122
40	...	...	0.152	0.00122	0.151	...
45	...	...	0.169	0.00135	...	...
50	...	...	...	...	0.164	...
55	...	...	0.212	0.00170	...	...
60	...	...	...	...	0.175	...
65	...	...	0.250	0.00200	...	...
73	...	...	0.285	0.00228	...	...
75	...	...	...	...	0.188	...
90	...	...	...	...	0.200	...
100	...	...	...	...	0.211	...

The following additional data for the solubility of the above three hydrates are given by (Kohlrausch, 1908).

BaC <sub>2</sub> O <sub>4</sub> . $\frac{3}{2}$ H <sub>2</sub> O.		BaC <sub>2</sub> O <sub>4</sub> .2H <sub>2</sub> O.		BaC <sub>2</sub> O <sub>4</sub> .H <sub>2</sub> O.	
t°.	Gms. per Liter.	t°.	Gms. per Liter.	t°.	Gms. per Liter.
2.07	0.0553	3	0.0519	0.08	0.08
4.2	0.059	5.47	0.0575	2.46	0.08
16.1	0.0962	11.28	0.0693	9.62	0.08
17.8	0.1047	17.9	0.085	15.04	0.08
		23.3	0.0987	17.54	0.08
		28.4	0.1124	27.02	0.08
				33.73	0.08

Cantoni and Diotalevi (1905) obtained higher results than either of the above. SOLUBILITIES OF BARIUM OXALATE (BaC<sub>2</sub>O<sub>4</sub>. $\frac{1}{2}$ H<sub>2</sub>O) IN AQUEOUS ACETIC ACID 26°-27°. (Herz and Muhs, 1903.)

Normality of Acetic Acid.	G. Residue* per 50 cc. Sol.	Gms. per 100 cc. Solution.		Normality of Acetic Acid.	G. Residue* per 50 cc. Sol.	Gms. per 100 CH <sub>3</sub> COOH.
		CH <sub>3</sub> COOH.	Ba Oxalate.			
0	0.0077	0.00	0.0154	3.85	0.0564	23.12
0.565	0.0423	3.39	0.0845	5.79	0.0511	34.76
1.425	0.0520	8.55	0.1039	17.30	0.0048	103.90
2.85	0.0556	17.11	0.1111	...	...	...

\* Dried at 70°.



**BARIUM ACID OXALATE**  $\text{BaC}_2\text{O}_4 \cdot \text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Groschuff.)

t°.	Gms. per 100 Gms. Solution.		Mols. per 100 Mols. $\text{H}_2\text{O}$ .		Mols. $\text{H}_2\text{C}_2\text{O}_4$ per 1 Mol. $\text{BaC}_2\text{O}_4$ .
	$\text{H}_2\text{C}_2\text{O}_4$ .	$\text{BaC}_2\text{O}_4$ .	$\text{H}_2\text{C}_2\text{O}_4$ .	$\text{BaC}_2\text{O}_4$ .	
0	0.27	0.030	0.054	0.0024	22
18	0.66	0.070	0.130	0.0056	24
20.5	0.76	0.076	0.15	0.0061	25
38	1.61	0.16	0.33	0.013	25
41	1.82	0.18	0.37	0.015	25
53	2.92	0.31	0.60	0.026	24
60	3.60	0.40	0.75	0.033	22.5
80	6.21	0.81	1.34	0.070	19
90	7.96	1.11	1.75	0.098	18
99	10.50	1.55	2.39	0.141	17

**BARIUM OXIDES.**

Data for the lowering of the fusion points (solubility, see footnote, p. 1), of mixtures of  $\text{BaO}$  and  $\text{B}_2\text{O}_3$  are given by Guertler (1904). Results for mixtures of  $\text{BaO}$  and  $\text{CaCl}_2$  and for  $\text{BaO}$  and  $\text{SrCl}_2$  are given by Sackur (1911-12).

**BARIUM Glycerol PHOSPHATES.**

## SOLUBILITY IN WATER.

f.	Compound.	Formula.	Gms. Anhydrous Salt per 100 Gms. Sat. Sol.	Authority.
21	Barium Glycerolphosphate	$\text{BaC}_3\text{H}_7\text{O}_4\text{P} \cdot \text{H}_2\text{O}$	4.5	(Rogier and Fiore, 1913.)
13	" $\alpha$ Glycerolphosphate	$\text{BaC}_3\text{H}_7\text{O}_4\text{P}$	1.4	(King and Pyman, 1914.)
12	" $\beta$ "	$\text{BaC}_3\text{H}_7\text{O}_4\text{P} \cdot \frac{1}{2}\text{H}_2\text{O}$	5.8	" "
11	" Glycerolphosphate	$\text{BaC}_3\text{H}_6\text{O}_4\text{P} \cdot \frac{1}{2}\text{H}_2\text{O}$	8.4	(Langheld and Oppmann, 1912.)
12	" di Glycerolphosphate	....	3.76	" "

**BARIUM PICRATE.** Solubility in  $\text{H}_2\text{O} + \text{C}_2\text{H}_5\text{OH}$  at 25°. (Fischer, 1914.)

**BARIUM PROPIONATE**  $\text{Ba}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot \text{H}_2\text{O}$ , also  $6\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Krasnicki — Monatsch. Chem. 8, 597, '87.)

t°.	Gms. $\text{Ba}(\text{C}_2\text{H}_3\text{O}_2)_2$ per 100 Gms.		t°.	Gms. $\text{Ba}(\text{C}_2\text{H}_3\text{O}_2)_2$ per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	47.98	32.41	50	62.74	38.57
10	51.56	34.02	60	64.76	39.31
20	54.82	35.42	70	66.46	39.93
30	57.77	36.65	80	67.85	40.42
40	60.41	37.66	..	...	...

100 cc. 95% ethyl alcohol dissolve 0.1631 gm. barium propionate at room temp. (Crowell, 1918)

**BARIUM SALICYLATE**  $\text{Ba}(\text{C}_6\text{H}_4\text{OHCOO})_2 \cdot \text{H}_2\text{O}$ .

100 gms. sat. aqueous solution contain 28.65 gms. anhydrous salt at 15° and 54.08 gms. at 100°. (Tarugi and Cherchi, 1901.)

**BARIUM DinitrosALICYLATE.** Solubility in  $\text{H}_2\text{O} + \text{C}_2\text{H}_5\text{OH}$  at 25°.

(Fischer, 1914.)

**BARIUM SILICATE**  $\text{BaSiO}_3$ .

Fusion-point curves (solubility, see footnote, p. 1) for mixtures of:

$\text{BaSiO}_3 + \text{CaSiO}_3$  and  $\text{BaSiO}_3 + \text{MnSiO}_3$  are given by (Lebedeu, 1911).

$\text{BaSiO}_3 + \text{Li}_2\text{SiO}_3$  and  $\text{BaSiO}_3 + \text{Na}_2\text{SiO}_3$  are given by Wallace, 1909.

$\text{BaSiO}_3 + \text{BaTiO}_3$  are given by Smolensky (1911-12).



## BARIUM STEARATE

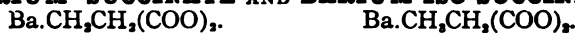
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### BARIUM STEARATE and Salts of Other Fatty Acids.

#### SOLUBILITY OF BARIUM STEARATE, PALMITATE, MYRISTATE AND LAURATE IN SEVERAL SOLVENTS. (Jacobson and Holmes, 1916.)

Solvent.	t°.	Gms. Each Salt (Determined Separately) per 100 Gms. Solvent			
		Ba Stearate.	Ba Palmitate.	Ba Myristate.	Ba Laurate.
Water	15.3	0.004	0.004	0.007	0.008
"	50	0.006	0.007	0.010	0.011
Abs. Ethyl Alcohol	16.5	0.006	0.009	0.009	0.010
"	50	0.003	0.004	0.004	0.007
Methyl Alcohol	15	0.042	0.045	0.057	0.084
"	50.5	0.077	0.088	0.108	0.163
Ether	25	0.001	0.001	0.003	0.007
Amyl Alcohol	25	0.007	0.008	0.009	0.009

### BARIUM SUCCINATE AND BARIUM ISO SUCCINATE



#### SOLUBILITY OF EACH IN WATER. (Miczyński — Monatsch. Chem. 7, 263, 1886.)

t°.	Gms. Ba. Succinate per 100 Gms.		Gms. Ba. Iso Succinate per 100 Gms.	
	Water.	Solution.	Water.	Solution.
0	0.421	0.420	1.884	1.849
10	0.432	0.430	2.852	2.774
20	0.418	0.417	3.618	3.493
30	0.393	0.392	4.181	4.014
40	0.366	0.365	4.542	4.346
50	0.337	0.336	4.700	4.594
60	0.306	0.305	4.656	4.450
70	0.273	0.272	4.410	4.224
80	0.237	0.237	3.962	3.810

100 gms.  $\text{H}_2\text{O}$  dissolve 0.396 gms. Ba Succinate at 18° and 0.41 gms. at 25°.

100 gms. 95% alcohol dissolve 0.0015 gms. Ba Succinate at 18° and 0.0016 gms. at 25°.

(Partheil and Hühner — Archiv. Pharm. 241, 413, 1908)

Cantoni and Diotalevi (1905), and Tarugi and Checchi (1901), obtained data in close agreement with the above.

### BARIUM SULFATE $\text{BaSO}_4$ .

#### SOLUBILITY IN WATER. (Kohlrausch, 1908.)

One liter of sat. solution contains 0.00115 gm.  $\text{BaSO}_4$  at 0°; 0.0020 gm. at 10°; 0.0024 gm. at 20° and 0.00285 gm. at 30°.

Melcher (1910) obtained results a little lower than the above. His data for higher temperatures are 0.00336 gm. at 50° and 0.0039 gm. at 100°.

Kohlrausch obtained the following results for the solubility of heavy spar ( $\text{BaSO}_4$ ): 0.0019 gm. at 0°, 0.0023 gm. at 10°; 0.0027 gm. at 20°; 0.00315 gm. at 30° and 0.0033 gm. at 33.5°.

100 gms. sat. solution of  $\text{BaSO}_4$  in 21.37% aqueous ammonium acetate solution contain 0.016 gm. at 25°.

(Marden, 1916.)

#### SOLUBILITY OF BARIUM SULFATE IN AQUEOUS SOLUTIONS OF IRON, ALUMINIUM AND MAGNESIUM CHLORIDES AT 20°-25°. (Fraps, 1901.)

Gms. Chloride per Liter.	Milligrams $\text{BaSO}_4$ per Liter in:			Gms. Chloride per Liter.	Mgs. $\text{BaSO}_4$ per Liter in:		
	Aq. $\text{FeCl}_3$ .	Aq. $\text{AlCl}_3$ .	Aq. $\text{MgCl}_2$ .		Aq. $\text{FeCl}_3$ .	Aq. $\text{AlCl}_3$ .	Aq. $\text{MgCl}_2$ .
1	58	33	30	25	150	116	50
2½	72	43	30	50	160	170	50
5	115	60	33	100	170	175	50
10	123	94	33	...	...	...	..



**SOLUBILITY OF BARIUM SULFATE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC  
AND OF NITRIC ACIDS.**

(Banthisch, 1884.)

In Hydrochloric Acid.				In Nitric Acid.			
cc. containing 1 Mg. Equiv. of HCl.	Mgs. BaSO <sub>4</sub> per 1 Mg. Equiv. of HCl.	Gms. per 100 cc. Solution.		cc. containing 1 Mg. Equiv. of HNO <sub>3</sub> .	Mgs. BaSO <sub>4</sub> per 1 Mg. Equiv. of HNO <sub>3</sub> .	Gms. per 100 cc. Solution.	
		HCl.	BaSO <sub>4</sub> .			HNO <sub>3</sub> .	BaSO <sub>4</sub> .
2.	0.133	1.82	0.0067	2.	0.140	3.15	0.0070
1.	0.089	3.65	0.0089	1.	0.107	6.31	0.0107
0.5	0.056	7.29	0.0101	0.5	0.085	12.61	0.0170
0.2	0.017	18.23	0.0086	0.2	0.048	31.52	0.0241

100 cc. HBr dissolve 0.04 gm. BaSO<sub>4</sub>; 100 cc. HI dissolve 0.0016 gm. BaSO<sub>4</sub> at the boiling point. (Haslam, 1886.)

**SOLUBILITY OF BARIUM SULFATE IN CONCENTRATED AQUEOUS SOLUTIONS OF  
SULFURIC ACID AT 20°.**

(Von Weimarn, 1911.)

Gms. H <sub>2</sub> SO <sub>4</sub> per 100 Gms. Solvent.	Gms. BaSO <sub>4</sub> per 100 cc. Sat. Sol.	Gms. H <sub>2</sub> SO <sub>4</sub> per 100 Gms. Solvent.	Gms. BaSO <sub>4</sub> per 100 cc. Sat. Sol.
73.83	0.0030	85.78	0.3215
78.04	0.0135	88.08	1.2200
80.54	0.0285	93	...*
83.10	0.0800	96.17	4.9665
84.15	...†	96.46	18.6900

\* Solid Phase = BaSO<sub>4</sub>(H<sub>2</sub>SO<sub>4</sub>)<sub>2</sub>·H<sub>2</sub>O + BaSO<sub>4</sub>·H<sub>2</sub>SO<sub>4</sub>. † Solid Phase = BaSO<sub>4</sub> + BaSO<sub>4</sub>·H<sub>2</sub>SO<sub>4</sub>·H<sub>2</sub>O.

Data for the above system are also given by Volkhouskii (1910).

100 cc. sat. solution of BaSO<sub>4</sub> in abs. H<sub>2</sub>SO<sub>4</sub> contain 28.51 gms. BaSO<sub>4</sub>, solid phase = BaSO<sub>4</sub>·30H<sub>2</sub>SO<sub>4</sub>. (Bergius, 1910.)

100 cc. of sat. solution of BaSO<sub>4</sub> in 95% formic acid contain 0.01 gm. BaSO<sub>4</sub> at 18.5°. (Aschan, 1913.)

Fusion-point curves (solubility, see footnote, p. 1) are given the following mixtures of barium sulfate and other salts:

BaSO <sub>4</sub> + NaCl	(Sackur, 1911-12.)
" + KCl	"
" + CaCl <sub>2</sub>	"
" + K <sub>2</sub> SO <sub>4</sub>	(Grahmann, 1913; Calcagni, 1912.)
" + Li <sub>2</sub> SO <sub>4</sub>	(Calcagni and Marotta, 1912.)
" + Na <sub>2</sub> SO <sub>4</sub>	(Calcagni, 1912.)

**BARIUM Amyl SULFATE** Ba(C<sub>5</sub>H<sub>11</sub>SO<sub>4</sub>)<sub>2</sub>·2H<sub>2</sub>O.

**SOLUBILITY OF MIXED CRYSTALS OF THE ACTIVE AND INACTIVE SALT IN  
WATER AT 20.5°.**

(Marckwald, 1904.)

Gms. Salt per 100 Gms. H <sub>2</sub> O.	Per cent Active Salt in Dissolved Salt.	Gms. Salt per 100 Gms. H <sub>2</sub> O.	Per cent Active Salt in Dissolved Salt.
28.2	100	18.3	49.6
26.3	91.6	16.6	36.3
24.8	84.5	15	25.8
21.7	71.2	13.6	10.6
19.5	59.5	12.8	0

Mixed crystals of the active and inactive barium amyl sulfate were dissolved in water by warming, then cooled to the beginning of crystallization and shaken two hours at 20.5°. The percentage of the active salt was determined by the polariscope. Its specific rotation was  $[\alpha]_D = +2.52^\circ$ .



## BARIUM SULFATE

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### BARIUM Isoamyl SULFATE $\text{Ba}(\text{C}_6\text{H}_{11}\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 9.71 gms. of the anhydrous salt at  $10^\circ$ , 11.85 gms. at  $19.3^\circ$  and 12.15 gms. at  $20.5^\circ$ .  
(Marckwald, 1902.)

### BARIUM Persulfate $\text{BaS}_2\text{O}_8 \cdot 4\text{H}_2\text{O}$ .

100 parts water dissolve 39.1 parts  $\text{BaS}_2\text{O}_8$  or 52.2 parts  $\text{BaS}_2\text{O}_8 \cdot 4\text{H}_2\text{O}$  at  $0^\circ$ .

(Marshall — J. Ch. Soc. 59, 771, '94)

### BARIUM SULFITE $\text{BaSO}_3$ .

#### SOLUBILITY IN WATER AND IN AQUEOUS SUGAR SOLUTIONS.

(Rogowicz — Z. Ver Zuckerind. 938, 1905.)

Conc. of Sugar Sol.	Gm. $\text{BaSO}_3$ per 100 cc. Sol.		Conc. of Sugar Sol.	Gm. $\text{BaSO}_3$ per 100 cc. Sol.	
	at $20^\circ$ .	at $80^\circ$ .		at $20^\circ$ .	at $80^\circ$ .
$0^\circ$ Bx	0.0197	0.00177	$40^\circ$ Bx	0.0048	0.00158
$10^\circ$ "	0.0104	0.00335	$50^\circ$ "	0.0030	0.00149
$20^\circ$ "	0.0097	0.00289	$60^\circ$ " (sat.)	0.0022	0.00112
$30^\circ$ "	0.0078	0.00223	...	...	...

## BARIUM SULFONATES.

#### SOLUBILITY OF SEVERAL BARIUM SULFONATES IN WATER.

Salt.	Formula.	t°.	Gms. Anhy- drous Salt per 100 Gms. $\text{H}_2\text{O}$ .	Authority.
Barium:				
3.4 Diiodobenzene Sulfonate	$\text{C}_6\text{H}_2\text{O}_4\text{I}_2\text{Ba} \cdot \text{H}_2\text{O}$	21.5	0.27	(Boyle, 1909.)
2.5 " "	$\text{C}_6\text{H}_2\text{O}_4\text{I}_2\text{Ba} \cdot \frac{1}{2}\text{H}_2\text{O}$	20	0.522	"
2 Phenanthrene Sulfonate	$(\text{C}_{14}\text{H}_9\text{SO}_3)_2\text{Ba} \cdot \frac{1}{2}\text{H}_2\text{O}$	20	0.016	(Sandquist, 1912.)
3 " "	$(\text{C}_{14}\text{H}_9\text{SO}_3)_2\text{Ba} \cdot 3\text{H}_2\text{O}$	20	0.03	"
10 " "	$(\text{C}_{14}\text{H}_9\text{SO}_3)_2\text{Ba} \cdot 3\text{H}_2\text{O}$	20	0.13	"
Bromobenzene Sulfonate	$(\text{C}_6\text{H}_4\text{BrSO}_3)_2\text{Ba}$	17.5	3.31	(Meyer, 1875.)

### BARIUM TARTRATE $\text{Ba}(\text{C}_2\text{H}_3\text{O}_4)_2$ .

#### SOLUBILITY IN WATER.

(Cantoni and Zachoder — Bull. soc. chim. [3] 33, 751, '05; see also Partheil and Hühner.)

t°.	Gms. $\text{Ba}(\text{C}_2\text{H}_3\text{O}_4)_2$ per 100 cc. Solution.	t°.	Gms. $\text{Ba}(\text{C}_2\text{H}_3\text{O}_4)_2$ per 100 cc. Solution.	t°.	Gms. $\text{Ba}(\text{C}_2\text{H}_3\text{O}_4)_2$ per 100 cc. Solution.
0	0.0205	30	0.0315	70	0.0480
10	0.0242	40	0.0352	80	0.0527
20	0.0279	50	0.0389	85	0.0541
25	0.0297	60	0.0440	..	...

#### SOLUBILITY OF BARIUM TARTRATE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE, SODIUM CHLORIDE AND AMMONIUM CHLORIDE.

(Cantoni and Jolkowski, 1907.)

##### At Different Temperatures.

##### Varying Concentrations at $16^\circ$ .

t°.	Gms. $\text{Ba}(\text{C}_2\text{H}_3\text{O}_4)_2$ per 100 cc. Sat. Sol. in:			Gms. Chloride per 100 Gms. Solvent.	Gms. $\text{Ba}(\text{C}_2\text{H}_3\text{O}_4)_2$ per 100 cc. Sat. Sol. in:		
	7% KCl.	7% NaCl.	7% $\text{NH}_4\text{Cl}$ .		KCl.	NaCl.	$\text{NH}_4\text{Cl}$ .
16	0.0823	0.0887	0.1050	0.5	0.0398	0.0410	0.0441
30	0.1017	0.1151	0.1370	1	0.0466	0.0514	0.0589
55	0.1230	0.1348	0.1590	3	0.0723	0.0826	0.0892
70	0.1500	0.1781	0.2030	10	0.1199	0.1260	0.1342
85	0.1828	0.2168	0.2360	15	0.1435	0.1440	0.1585
				20	0.1466	0.1573	0.1663

(See Note p. 222.)



**SOLUBILITY OF BARIUM TARTRATE IN AQUEOUS ACETIC ACID SOLUTIONS AT 26°-27°.**

(Herz and Muhs, 1903.)

Normality of Acetic Acid.	Gms. residue* per 50 cc. Sol.	Gms. per 100 cc. Solution. CH <sub>3</sub> COOH. Ba tartrate.		Normality of Acetic Acid.	Gms. residue* per 50 cc. Sol.	Gms. per 100 cc. Solution. CH <sub>3</sub> COOH. Ba tartrate.	
0	0.0328	0.	0.0655	3.77	0.1866	22.62	0.3728
0.565	0.1151	3.39	0.2300	5.65	0.1865	33.90	0.3726
1.425	0.1559	8.55	0.3115	16.85	0.0218	101.10	0.0436
2.85	0.1739	17.11	0.3475	...	...	...	...

\* Dried at 70°

100 grams 95% alcohol dissolve 0.032 gm. Ba tartrate at 18° and 0.0356 gm. at 25°.

(Partheil and Hubner.)

**BARIUM β TRUXILATE.** BaC<sub>12</sub>H<sub>14</sub>O<sub>4</sub>·2H<sub>2</sub>O.

100 cc. sat. solution in water contain 0.028 gm. of the salt at 26°. (de Jong, 1912.)

**BEHENIC ACID** C<sub>22</sub>H<sub>44</sub>COOH.

Freezing-point data (solubility, see footnote, p. 1) are given for the following mixtures of behenic acid and other compounds.

Behenic Acid + Erusic Acid	(Mascarelli and Sanna, 1915.)
" + Isoerusic Acid	" "
" + Brassidinic Acid	" "
" + Isobehenic Acid	(Meyer, Brod and Soyka, 1913.)
" Methylene + Isobehenic Acid Methyl Ester.	" "

**BENZALANILINE** C<sub>6</sub>H<sub>5</sub>CH:N.C<sub>6</sub>H<sub>5</sub>.

Solubility data determined by the freezing-point method are given by Pascal and Normand (1913), for mixtures of benzalaniline and each of the following compounds: Azobenzene, benzylaniline, dibenzyl, hydrazobenzene, stilbene and tolane.

**BENZALAZINE** C<sub>6</sub>H<sub>5</sub>CH:N.N:CHC<sub>6</sub>H<sub>5</sub>.

Solubility data determined by the freezing-point method are given by Pascal (1914), for mixtures of benzalazine and each of the following compounds: Diphenylhydrazine, diphenyldiacetylene, naphthalene, furfuralazine, diphenylbutadiene and cinnamylidene. Data are also given for mixtures of thiophenylazoline and cinnamylidene.

**BENZALDEHYDE** C<sub>6</sub>H<sub>5</sub>CHO.

100 gms. H<sub>2</sub>O dissolve 0.3 gm. C<sub>6</sub>H<sub>5</sub>CHO at room temp. (Fluckinger, 1875; U. S. P.)

Freezing-point data for mixtures of C<sub>6</sub>H<sub>5</sub>CHO and HNO<sub>3</sub> are given by Zukow and Kasatkin (1909).

**Para Hydroxy BENZALDEHYDE** *p* C<sub>6</sub>H<sub>4</sub>OH.CHO.

Freezing-point data are given for mixtures of *p* hydroxybenzaldehyde + dimethylaniline and *p* hydroxybenzaldehyde + phenol. (Schmidlin and Lang, 1912.)

**Ortho Nitro BENZALDEHYDE** *o* C<sub>6</sub>H<sub>4</sub>NO<sub>2</sub>.CHO.

**SOLUBILITY IN WATER AND IN AQUEOUS SOLUTIONS AT 25°.**

(Goldschmidt and Sunde, 1906.)

Solvent.	Gms. C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> . CHO per 100 cc. Sat. Sol.	Solvent.	Gms. C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> . CHO per 100 cc. Sat. Sol.	Solvent.	Gms. C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> . CHO per 100 cc. Sat. Sol.
H <sub>2</sub> O	0.2316	1 <i>n</i> NaCl	0.1899	1 <i>n</i> KNO <sub>3</sub>	0.3199
0.5 <i>n</i> HCl	0.2391	2 <i>n</i> "	0.1390	2 <i>n</i> "	0.3419
1 <i>n</i> "	0.2466	0.5 <i>n</i> HNO <sub>3</sub>	0.3207	0.5 <i>n</i> NaNO <sub>3</sub>	0.3013
2 <i>n</i> "	0.2658	1 <i>n</i> "	0.3758	1 <i>n</i> "	0.3132
1 <i>n</i> KCl	0.2046	0.5 <i>n</i> KNO <sub>3</sub>	0.3123	2 <i>n</i> "	0.3201
2 <i>n</i> "	0.1912				



# BENZALDEHYDE

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Meta Nitro**BENZALDEHYDE**  $m$   $C_6H_4NO_2.CHO$ .

100 cc.  $H_2O$  dissolve 0.1625 gm.  $m$   $C_6H_4NO_2.CHO$  at  $25^\circ$  (Goldschmidt and Sunde, 1906.)  
 " 1  $n$   $HCl$  " 0.1813 " " " " "  
 " 1  $n$   $KCl$  " 0.1542 " " " " "  
 " 2  $n$   $KCl$  " 0.1417 " " " " "

Para Nitro**BENZALDEHYDE**  $p$   $C_6H_4NO_2.CHO$ .

Data for the system  $p$  nitrobenzaldehyde + nitrobenzene + hexane are given by Timmermans (1907).

Solubility data determined by the freezing-point method are given for:

$p$  Nitrobenzaldehyde + Sulfuric Acid (Kendall, 1914.)  
 $m$  " + Benzene (Schmidlin and Lang, 1912.)  
 $m$  " + Phenol "

**BENZALDOXIME**  $C_6H_5CH:NOH$ .

Solubility data determined by the freezing-point method are given for mixtures of:

$\alpha$  Benzaldoxime +  $\beta$  Benzaldoxime (Cameron, 1898.)  
 $\alpha$  Nitrobenzaldoxime +  $\beta$  Nitrobenzaldoxime. (Beck, 1904.)

**BENZAMIDE**  $C_6H_5CONH_2$ .

## SOLUBILITY IN ETHYL ALCOHOL.

(Speyera — Am. J. Sci. [4] 14, 295, '02.)

$t^\circ$ .	Sp. Gr. of Solutions.	G. M. $C_6H_5CONH_2$ per 100 G.M. $C_2H_5OH$ .	Gms. $C_6H_5CONH_2$ per 100 Gms. $C_2H_5OH$ .	$t^\circ$ .	Sp. Gr. of Solutions.	G. M. $C_6H_5CONH_2$ per 100 G.M. $C_2H_5OH$ .	Gms. $C_6H_5CONH_2$ per 100 Gms. $C_2H_5OH$ .
0	0.833	3.1	8.15	40	0.848	11.0	28.92
10	0.832	4.2	11.04	50	0.862	14.2	37.34
20	0.833	5.9	15.52	60	0.881	17.2	45.22
25	0.835	6.8	17.87	70	0.913	20.4	53.63
30	0.838	8.2	21.56	..	...	...	...

## SOLUBILITY OF BENZAMIDE IN MIXTURES OF ALCOHOL AND WATER AT $25^\circ$ .

(Holleman and Antusch — Rec. trav. chim. 13, 294, '94.)

Vol. % Alcohol.	Gms. $C_6H_5CONH_2$ per 100 Gms. Solvent.	Sp. Gr. of Solutions.	Vol. % Alcohol.	Gms. $C_6H_5CONH_2$ per 100 Gms. Solvent.	Sp. Gr. of Solutions.
100	17.03	0.830	70	23.87	0.925
95	21.12	0.856	60	18.98	0.939
90	24.50	0.878	50	13.74	0.949
85	26.15	0.895	40	8.62	0.958
83	26.63	0.900	31	5.33	0.967
80	26.43	0.907	15	2.28	0.982
75	25.41	0.917	0	1.35	0.999

See remarks under  $\alpha$  Acetnaphthalide, p. 13.

100 gms. pyridine dissolve 31.23 gms. benzamide at  $20^\circ$ - $25^\circ$ . (Dehn, 1917.)

100 gms. aq. 50% pyridine dissolve 39.15 gms. benzamide at  $20^\circ$ - $25^\circ$ . "

The coefficient of distribution of benzamide between oil and water is 0.66 at  $3^\circ$  and 0.43 at  $36^\circ$ . (Meyer, 1900, 1905.)

**BENZANILIDE.**

Solubilities determined by the freezing-point method are given by Vanstone (1913) for mixtures of benzanilide and each of the following compounds: benzil, benzylideneaniline, and benzoin.

Results for mixtures of  $o$  chlorobenzanilide and  $p$  chlorobenzanilide are given by King and Orton (1911).



**BENZENE**  $C_6H_6$ .

## SOLUBILITY IN WATER AT 22°.

(Herz — Ber. 31, 2671, '98.)

100 cc. water dissolve 0.082 cc.  $C_6H_6$ , Vol. of Sol. = 100.082,  
 Sp. Gr. = 0.9979.  
 100 cc.  $C_6H_6$  dissolve 0.211 cc.  $H_2O$ , Vol. of sol. = 100.135,  
 Sp. Gr. = 0.8768.

## SOLUBILITY OF WATER IN BENZENE.

(Groschuff, 1911.)

t°.	Gms. $H_2O$ per 100 Gms. Sat. Sol.	t°.	Gms. $H_2O$ per 100 Gms. Sat. Sol.
3	0.030	55	0.184
23	0.061	66	0.255
40	0.114	77	0.337

**BENZENE**, Aq. ALCOHOL MIXTURES; **BENZENE**, Aq. ACETONE MIXTURES AT 20°.

$H_2O$  added to mixtures of known amounts of the other two and appearance of clouding noted.

(Bancroft — Phys. Rev. 3, 31, 1895.96.)

 $C_6H_6$ ,  $C_2H_5OH$  and  $H_2O$      $C_6H_6$ ,  $CH_3OH$  and  $H_2O$      $C_6H_6$ ,  $(CH_3)_2CO$  and  $H_2O$ 

Per 5 cc. $C_2H_5OH$ .		Per 5 cc. $CH_3OH$ .		Per 5 cc. $(CH_3)_2CO$ .	
cc. $H_2O$ .	cc. $C_6H_6$ .	cc. $H_2O$ .	cc. $C_6H_6$ .	cc. $H_2O$ .	cc. $C_6H_6$ .
20	0.03	5.0	0.15	8.0	0.10
8	0.13	3.0	0.215	3.0	0.395
4	0.39	2.0	0.59	2.0	0.69
2	1.17	1.4	1.0	1.3	1.0
1.5	1.87	1.0	1.9	0.51	2.0
1.0	3.57	0.8	3.0	0.295	3.0
0.605	8.0	0.69	4.0	0.2	4.0
0.34	20.0	0.49	8.0	0.15	5.0

$C_2H_5OH$  added to mixtures of known amounts of  $C_6H_6$  and  $H_2O$  until the solutions became homogeneous at 20°.

(Lincoln, 1900.)

Per 5 cc. $C_6H_6$ .		Per 5 cc. $C_6H_6$ .		Per 5 cc. $C_6H_6$ .	
cc. $H_2O$ .	cc. $C_2H_5OH$ .	cc. $H_2O$ .	cc. $C_2H_5OH$ .	cc. $H_2O$ .	cc. $C_2H_5OH$ .
1	4.6	20	31.6	50	58
5	12.8	30	41.4	60	65.6
10	19.8	40	39.5	70	73.1

Lincoln also gives results at 10°. Data of a similar character for mixtures of benzene, ethyl alcohol and water at 20, 25 and 35° are given by Taylor (1897).

For results at 15°, see page 287.

Data for mixtures of benzene, ethyl alcohol and glycerol and for mixtures of benzene, ethyl alcohol and lactic acid are given by Rozsa (1911).

## MUTUAL SOLUBILITY OF BENZENE AND CARBON TETRACHLORIDE.

(Determined by the synthetic method.)

(Baud, 1913.)

t°.	Gms. $C_6H_6$ per 100 Gms. Mixture.	t°.	Gms. $C_6H_6$ per 100 Gms. Mixture.	t°.	Gms. $C_6H_6$ per 100 Gms. Mixture.
-24.2	0	-40	19.3	-20	48
-30	2.8	-34	24.2	-10	64.1
-40	8.5	-35 tr. pt.	31	0	85.3
-46.3 Eutec.	12.9	-30	36	+ 5.5	100



MUTUAL SOLUBILITY OF BENZENE AND CHLOROFORM. FREEZING-POINT METHOD. (Wroczyński and Guye, 1910.)

t°.	Gms. C <sub>6</sub> H <sub>6</sub> per 100 Gms. Solution.	Solid Phase.	t°.	Gms. C <sub>6</sub> H <sub>6</sub> per 100 Gms. Solution.	Solid Phase.	t°.	Gms. C <sub>6</sub> H <sub>6</sub> per 100 Gms. Solution.
-63.5	0	CHCl <sub>3</sub>	-60	26.8	C <sub>6</sub> H <sub>6</sub>	-20	58.3
-70	11.8	"	-50	32	"	-10	70.8
-75	14.7	"	-40	39	"	0	88
-81.7	18.4	CHCl <sub>3</sub> +C <sub>6</sub> H <sub>6</sub>	-30	47.8	"	5	100
-70	22.6	C <sub>6</sub> H <sub>6</sub>					

The eutectic point was found by extending the curves to their intersection. The temperature of the eutectic could not be reached by use of liquid CO<sub>2</sub>.

MUTUAL SOLUBILITY OF BENZENE AND FORMIC ACID. SYNTHETIC METHOD. (Ennis, 1914.)

t° of Miscibility.	Gms. HCOOH per 100 Gms. Sol.	t° of Miscibility.	Gms. HCOOH per 100 Gms. Sol.	t° of Miscibility.	Gms. HCOOH per 100 Gms. Sol.
21	9.2	70	31.5	60	74
30	10.3	72	35	40	82
40	12.2	73.2	43-51	20	87
50	16.5	72	60	5	89.6
60	22	70	65		

SOLUBILITY OF BENZENE IN AQUEOUS SOLUTIONS OF FORMIC ACID. SYNTHETIC METHOD. (Ennis, 1914.)

In 95 Wt. % HCOOH.		In 85 Wt. % HCOOH.		In 75 Wt. % HCOOH.		In 60 Wt. % HCOOH.	
t° of Miscibility.	Gms. C <sub>6</sub> H <sub>6</sub> per 100 Gms. Sol.	t° of Miscibility.	Gms. C <sub>6</sub> H <sub>6</sub> per 100 Gms. Sol.	t° of Miscibility.	Gms. C <sub>6</sub> H <sub>6</sub> per 100 Gms. Sol.	t° of Miscibility.	Gms. C <sub>6</sub> H <sub>6</sub> per 100 Gms. Sol.
57.5	96.3	71	97.5	122	12	105	6
77	94.4	87	96.6	97.5	8.5	82	3.
95	89.8	101	96	74	6	76	3
112	85.2	100.5	14.3				
94.5	24.7	81	10				
80.5	20	46	7				
51	12.5						

MUTUAL SOLUBILITY OF BENZENE AND ETHYL ALCOHOL. FREEZING-POINT METHOD. (Viala, 1914; see also Rozsa, 1911 and Pickering, 1893.)

t°.	Gms. C <sub>6</sub> H <sub>6</sub> per 100 Gms. Sol.	t°.	Gms. C <sub>6</sub> H <sub>6</sub> per 100 Gms. Sol.	t°.	Gms. C <sub>6</sub> H <sub>6</sub> per 100 Gms. Sol.
-113.9	0	-60	19.3	-10	57.6
-100	8	-50	24.1	0	85
-90	10	-40	29.8	1	93
-80	12	-30	37	5.5	100
-70	15	-20	45.7		

MUTUAL SOLUBILITY OF BENZENE AND  $\beta$  NAPHTHALENE PICRATE, C<sub>6</sub>H<sub>5</sub>(NO<sub>2</sub>)<sub>2</sub>OH.C<sub>10</sub>H<sub>7</sub>OH. (Kuriloff, 1897.)

Synthetic method used — see Note, p. 16

t°.	Gms. Picrate	Gms. Benzene	$\alpha$	t°.	Gms. Picrate.	Gms. Benzene.	$\alpha$
157	100.	...	100.0	111.6	1.173	1.037	19.2
148.4	2.128	0.115	79.3	102.0	1.087	1.780	11.2
137.4	1.274	0.170	61.1	29.5	0.390	8.430	0.9
134.2	1.384	0.297	49.3	4.6	1.329	21.80	0.4
126.8	1.019	0.343	38.3	5.02	...	100.0	..

$\alpha$  = Mols.  $\beta$  Naphthalene Picrate per 100 Mols. of  $\beta$  Naphthalene Picrate plus Benzene.

Determinations for a large number of isothermes are also given.



## THE SYSTEM BENZENE, PHENOL AND WATER AT 25°.

(Horiba, 1914.)

In the case of phenol, the bromine method was used for its determination. In the case of the other two compounds, the amounts required to produce constant density were measured directly from burettes.

## Solubility of Benzene in Aqueous Solutions Containing Phenol and Vice Versa.

## Solubility of Phenol in Benzene Solutions Containing Water and Vice Versa.

$d_{25}^4$	Gms. per 100 Gms. $\text{C}_6\text{H}_5\text{OH} + \text{C}_6\text{H}_6 + \text{H}_2\text{O}$		Saturating Phase.	$d_{25}^4$	Gms. per 100 Gms. $\text{C}_6\text{H}_5\text{OH} + \text{C}_6\text{H}_6 + \text{H}_2\text{O}$		Saturating Phase.
	$\text{C}_6\text{H}_5\text{OH}$	$\text{C}_6\text{H}_6$			$\text{C}_6\text{H}_5\text{OH}$	$\text{C}_6\text{H}_6$	
0002	0	0.198	$\text{C}_6\text{H}_6$	...	29.29	0	$\text{C}_6\text{H}_5\text{OH}$
0008	1.059	0.204	"	...	71.63	1.62	"
0021	2.602	0.205	"	...	74.5	3	$\text{C}_6\text{H}_5\text{OH} + \text{C}_6\text{H}_6$
00305	3.526	0.199	"	1.0256	69.18	16.33	$\text{C}_6\text{H}_6$
...	5.65	0.17	$\text{C}_6\text{H}_6 + \text{C}_6\text{H}_5\text{OH}$	0.9891	55.80	36.13	"
...	5.953	0.132	$\text{C}_6\text{H}_5\text{OH}$	0.9629	44.39	50.56	"
0059	6.516	0.075	"	0.9142	21.15	77.22	"
0069	7.683	0.025	"	0.8818	4.78	94.98	"
0073	8.195	0	"	0.8764	0	99.95	"

Data are also given for the solubility of phenol as solid phase, in  $\text{C}_6\text{H}_6$  and in water and in their mixtures. A complete table for the conjugate points, showing the distribution of phenol between the aqueous and the benzene layers, is given. The results agree with those of Rothmund and Wilshire. See page 482.

## RECIPROCAL SOLUBILITY, DETERMINED BY FREEZING-POINT METHOD, OF MIXTURES OF

Benzene and Phenol. (Hatcher and Skirrow, 1917.)			Benzene and Pyridine. (Hatcher and Skirrow, 1917.)		
$t^\circ$ of Melting.	Gms. $\text{C}_6\text{H}_6$ per 100 Gms. Mixture.	Solid Phase.	$t^\circ$ of Melting.	Gms. $\text{C}_6\text{H}_6$ per 100 Gms. Mixture.	Solid Phase.
39.4	0	$\text{C}_6\text{H}_5\text{OH}$	-39.4	0	$\text{C}_6\text{H}_5\text{N}$
30	11.8	"	-45	10	"
20	25	"	-50	17	"
10	38.2	"	-55	23.3	"
0	51.5	"	-58 Eutec.	26	" + $\text{C}_6\text{H}_6$
-5.4 Eutec.	58.4	" + $\text{C}_6\text{H}_6$	-50	31	$\text{C}_6\text{H}_6$
-2.5	67.5	$\text{C}_6\text{H}_6$	-40	37.7	"
0	78.3	"	-30	46	"
+2.5	89	"	-20	57	"
5.1	100	"	-10	71.5	"
			0	90.5	"

Additional data on the system Benzene + Phenol are given by Dahms, 1895; Paterno and Ampola, 1897; Tsakalotos and Guye, 1910, and Rosza, 1911. Additional data on the system Benzene + Pyridine are given by Pickering, 1893.

## SOLUBILITY OF BENZENE IN SULPHUR.

By "Synthetic Method" see Note, p. 16.

(Alexejew, 1886.)

$t^\circ$	Gms. $\text{C}_6\text{H}_6$ per 100 Gms. S Layer. $\text{C}_6\text{H}_6$ Layer.		$t^\circ$	Gms. $\text{C}_6\text{H}_6$ per 100 Gms. S Layer. $\text{C}_6\text{H}_6$ Layer.	
100	6	75	140	16	61
110	8	75	150	19	55
120	10	72.5	160	25	45
130	12	66	164 (crit. temp.)	35	



SOLUBILITY DATA, DETERMINED BY THE FREEZING-POINT METHOD (see footnote, p. 1), ARE GIVEN FOR THE FOLLOWING MIXTURES:

Benzene + Benzoic acid	(Roloß, 1895. See Benzoic Acid, p. 135.)
" + <i>o</i> Nitrobenzylchloride	(Schmidlin and Lang, 1912.)
" + Bromoform	" "
" + Tetramethyldiamino benz- hydrol	" "
" + Benzhydrol	" "
" + Nitrobenzene	(Dahms, 1895.)
" + <i>o, m</i> and <i>p</i> Chloronitrobenzene	(Bogojawlensky, Winogradow and Bogolubow
" + <i>m</i> Bromonitrobenzene	{ (1906.)
" + <i>o, m</i> and <i>p</i> Dinitrobenzene	(Kremann, 1908.)
" + Carbon disulfide	(Pickering 1893.)
" + Camphene	(Kurnakoff and Efrehoff, 1912.)
" + <i>m</i> Cresol	(Kremann and Borjanovics, 1916.)
" + Cyclohexane	(Mascarelli and Pestalozza, 1907, 1908.)
" + Diphenyl	(Washburn and Read, 1915.)
" + Diethylamine	(Pickering, 1893.)
" + Diphenylamine	(Bruni, 1898; Dahms, 1895.)
" + Ethyl ether	(Pickering, 1893.)
" + Ethylene bromide	(Dahms, 1895.)
" + Ethylene dibromide	(Baud and Gay, 1911.)
" + Ethylene chloride	(Baud and Gay, 1910.)
" + Ethylene dichloride	(Baud and Gay, 1911.)
" + Menthol	(Dahms, 1895.)
" + Methyl alcohol	(Pickering, 1893.)
" + Naphthalene	{ (Bruni, 1898; Pickering, 1893; Washburn and
" + " + $\beta$ Naphthol	{ Read, 1915.)
" + " + Diphenylamine	(Bruni, 1898.)
" + Phenanthrene	"
" + " + Carbazol	"
" + Paraldehyde	(Paterno and Ampola, 1891, 1897.)
" + <i>o, m</i> and <i>p</i> Nitrophenol	{ (Bogojawlensky, Winogradow and Bogolubow
" + Propyl alcohol	{ 1906.)
" + Quinine	(Pickering, 1893.)
" + Thiophene	(Van Iterson-Rotgans, 1913.)
" + Bromotoluene	(Tsakalotos and Guye, 1910.)
" + 1.2.4, 1.2.6 and 1.3.4 Dinitro- toluene	(Paterno and Ampola, 1897.)
" + Urethan	{ (Kremann, 1908.)
" + <i>p</i> Xylene	(Pushin and Glagoleva and Masarovich, 1914.)
Bromobenzene + Chlorobenzene	(Paterno and Ampola, 1897.)
" + Iodobenzene	(Pascal, 1913.)
" + Fluorobenzene	"
<i>p</i> Dibromobenzene + <i>o</i> Dibromobenzene	(Holleman and van der Linden, 1911.)
" + <i>p</i> Dichlorobenzene	{ (Bruni and Gorni, 1899; Küster and Würfel, 1
" + <i>p</i> Diiodobenzene	{ 05; Kruyt, 1912.)
" + <i>p</i> Bromiodoben- zene	(Nagornow, 1911.)
" + <i>p</i> Chlorobromo- benzene	{ " "
" + <i>p</i> Chloronitroben- zene	{ (Bruni and Gorni, 1899.)
" + <i>m</i> " "	{ (Pawlewski, 1898.)
" + <i>p</i> Bromotoluene	{ " "
	(Borodowski and Bogojawlenski, 1904.)



SOLUBILITY OF *p* DIBROMOBENZENE IN SEVERAL SOLVENTS AT 25°.  
(Hildebrand, Ellefson and Beebe, 1917.)

Solvent.	Gms. C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub> ( <i>p</i> ) per 100 Gms. Solvent.	Solvent.	Gms. C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub> ( <i>p</i> ) per 100 Gms. Solvent.
Methyl Alcohol	10.35	Carbon Tetrachloride	36.6
Benzene	83.8	Ethyl Ether	71.3
Carbon Disulfide	90	Hexane	25.9

**DiBromoBENZENE (*p*) C<sub>6</sub>H<sub>4</sub>Br<sub>2</sub>.**

SOLUBILITY IN ETHYL, PROPYL, ISO BUTYL ALCOHOLS, ETC.  
(Schröder — Z. physik. Chem. 11, 456, '93.)

Determinations by "Synthetic Method" see Note, p. 16.

°.	Grams C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub> ( <i>p</i> ) per 100 Grams Sat. Solution in:						
	C <sub>2</sub> H <sub>5</sub> OH.	C <sub>3</sub> H <sub>7</sub> OH.	(CH <sub>3</sub> )CH <sub>2</sub> CH <sub>2</sub> OH.	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	CS <sub>2</sub> .	C <sub>6</sub> H <sub>6</sub> .	C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub> .
0	...	..	...	..	27	..	..
10	...	..	...	30	34	34	22
20	...	..	...	38	43	43	29
30	14	..	15	47	53	53	36
40	19	..	20	57	62	62	45
50	26	27	30	67	72	71	54
60	38	40	44	77	81	80	67
70	57.6	67	65	87	90	88	79
75	80.5	85	77	..	..	..	84
80	94.4	95	94.6	..	..	..	90

SOLUBILITY OF MIXTURES OF *p* DIBROMOBENZENE AND *p* DICHLOROBENZENE  
IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL

Solvent, 50 Vol. % C<sub>2</sub>H<sub>5</sub>OH, *t* = 49.1°. Solvent, 90.9 Vol. % C<sub>2</sub>H<sub>5</sub>OH, *t* = 25°  
(Küster and Dahmer, 1905.) (Küster and Würfel, 1904-05.)

Gms. per 100 cc. Sat. Sol.			Mol. % C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub> in Solute.	Gms. per 100 cc. Sat. Sol.		
C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub> .	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> .			C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub> .	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub> .	Mol. % C <sub>6</sub> H <sub>4</sub> Br <sub>2</sub> in Solute.
0.484	0	100		2.909	0	100
0.505	0.044	89.8		2.674	0.696	94.3
0.496	0.084	80.7		2.220	2.808	70.7
0.477	0.503	59.3		1.769	4.249	49.1
0.470	0.721	54.4		1.271	6.237	24.5
0.196	1.311	11.6		0.675	6.877	9.9
0	1.614	0		0	8.271	0

Additional data for the above system are given by Thiel (1903).

Tribromo BENZENE, C<sub>6</sub>H<sub>3</sub>Br<sub>3</sub>. Solubility, gms. per 100 gms. at 20-25°:  
In H<sub>2</sub>O, 0.004; in pyridine, 24.3; in Aq. 50% pyridine, 2.01. (Dehn, 1917.)

SOLUBILITY DATA, DETERMINED BY THE FREEZING-POINT METHOD (see footnote, p. 1), ARE GIVEN FOR THE FOLLOWING MIXTURES.

<i>p</i> Bromochlorobenzene	+ <i>p</i> Dichlorobenzene	(Bruni and Garni, 1899.)
"	+ <i>o</i> Bromochlorobenzene	(Holleman and Van der Linden, 1911.)
<i>p</i> Bromiodobenzene	+ <i>p</i> Diiodobenzene	(Nagornow, 1911.)
<i>o</i> Bromonitrobenzene	+ <i>o</i> Chloronitrobenzene	(Kremann; Kremann and Ehrlich, 1908.)
"	+ <i>p</i> Bromonitrobenzene	(Holleman & de Bruyn, 1900; Narbutt, '05.)
"	+ <i>o</i> "	(Narbutt, 1905.)
"	+ <i>p</i> "	"
"	+ <i>m</i> Chloronitrobenzene	(Hasselblatt, 1913; Küster, 1891.)
"	+ <i>m</i> Iodonitrobenzene	(Hasselblatt, 1913.)
"	+ <i>m</i> Fluoronitrobenzene	"
"	+ <i>m</i> Chloronitrobenzene	(Kremann, 1908.)
<i>p</i> "	+ <i>p</i> "	(Kremann, 1908; Isaac, 1913; Kremann & Ehrlich, 1908.)



ChloroBENZENE  $C_6H_5Cl$ .

## SOLUBILITY OF CHLOROBENZENE IN SULPHUR.

"Synthetic Method," see page 16.

(Alexjew.)

t°.	Grams $C_6H_5Cl$ per 100 Grams.	
	Sulphur Layer.	Chlor Benzene Layer.
90	13	70
100	18.5	63
110	27	53
116 crit. temp.	38	

*p*-DichloroBENZENE,  $C_6H_4Cl_2$ . *o* and *m* ChloronitroBENZENE,  $C_6H_4ClNO_2$ .

## SOLUBILITY OF EACH IN LIQUID CARBON DIOXIDE.

(Büchner, 1905-06.)

<i>p</i> -Dichlorobenzene.		<i>o</i> Chloronitrobenzene.		<i>m</i> Chloronitrobenzene.	
t°.	Gms. $p$ $C_6H_4Cl_2$ per 100 Gms. Sat. Solution.	t°.	Gms. <i>o</i> $C_6H_4ClNO_2$ per 100 Gms. Sat. Solution.	t°.	Gms. <i>m</i> $C_6H_4ClNO_2$ per 100 Gms. Sat. Solution.
-33	1.2	-32	1	-1	1.8
-10	4.2	+5	7.8	+16.5	11.2
+10	11.4	7	16.5-36 quad. pt.	7.5	38.2 quad. pt.
20	22.7	8	58.8	20	53.2
22	34.4	11	65.8		

SOLUBILITY OF *o*, *m* AND *p* CHLORONITROBENZENES IN ANILINE, DETERMINED BY THE FREEZING-POINT METHOD (see also p. 77).

(Kreman, 1907.)

t°.	Gms. Each Compound (Determined Separately) per 100 Gms. Sat. Sol.		
	<i>o</i> $C_6H_4ClNO_2$ .	<i>m</i> $C_6H_4ClNO_2$ .	<i>p</i> $C_6H_4ClNO_2$ .
-10	43.19 (=31 Mol. %)	21.60 (=14 Mol. %)	27.75 (=18.5 Mol. %)
-2.5	51.30 (=39 " "	31.67 (=21.5 " "	31.67 (=21.5 " "
+10	69.15 (=57 " "	49.29 (=36.5 " "	38.50 (=27 " "

## SOLUBILITY DATA, DETERMINED BY THE FREEZING-POINT METHOD (see footnote, p. 1), ARE GIVEN FOR THE FOLLOWING MIXTURES:

Chlorobenzene	+ Iodobenzene	(Pascal, 1913.)
"	+ Cyanbenzene	"
"	+ Fluorobenzene	"
<i>o</i> Dichlorobenzene	+ <i>p</i> Dichlorobenzene	(Holleman and Van der Linden, 1911.)
<i>p</i> " "	+ <i>p</i> Diiodobenzene	(Nagornow, 1911.)
"	+ <i>p</i> Chloriodobenzene	"
1,2,4 Trichlorobenzene	+ 1,2,3 Trichlorobenzene	(Van der Linden, 1912.)
"	+ 1,3,5 " "	"
"	+ " " + 1,2,3 Trichlorobenzene	"
$\alpha$ Hexachlorobenzene	+ $\beta$ Hexachlorobenzene	"
<i>p</i> Chloriodobenzene	+ <i>p</i> Diiodobenzene	(Nagornow, 1911.)
<i>o</i> Chloronitrobenzene	+ <i>p</i> Chloronitrobenzene	(Holleman and de Bruyn, 1900.)
"	+ " "	(Bogaiawlesky, Winogradow and Bogolubow, 1906.)
"	+ Formic acid	(Bruni and Berti, 1900.)
<i>m</i> " "	+ <i>m</i> Iodonitrobenzene	(Hasselblatt, 1913.)
"	+ <i>m</i> Fluoronitrobenzene	"
"	+ Naphthalene	(Kreman and Rodenis, 1906.)
<i>p</i> " "	+ Diphenylamine	(Tinkler, 1913.)
"	+ Naphthalene	(Kreman and Rodenis, 1906.)
<i>o</i> Iodonitrobenzene	+ <i>p</i> Iodonitrobenzene	(Holleman, 1913.)
<i>m</i> Benzene disulfone chloride	+ <i>p</i> Benzene disulfone chloride.	(Holleman and Pollak, 1910.)



**MUTUAL SOLUBILITY OF NITROBENZENE AND WATER**  
(Campetti and Del Grosso, 1913; Davis, 1916.)

t°.	Gms. C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub> per 100 Gms.		t°.	Gms. C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub> per 100 Gms.	
	H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub> Layer.		H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub> Layer.
20	0.19	99.76	180	4.2	93.7
40	0.3	99.6	200	7.2	91
60	0.4	99.3	220	11.8	87
80	0.8	99	230	15.8	83
100	1	98.7	240	23	72
120	1.3	98.2	241	26	67
140	1.9	97.2	242	32	58
160	2.8	95.8	244.5	crit. t.	50.1

Data for the solubility of nitrobenzene in hexane, diisooamyldecane and American petroleum at pressures up to 3000 atmospheres, are given by Kohnstamm and Timmermans (1913).

**SOLUBILITY OF *o*, *m* AND *p* NITROBENZENE IN WATER AND IN PYRIDINE.**  
(Dehn, 1917.)

Solvent.	t°.	Gms. Each Compound Separately per 100 Gms. Solvent.		
		<i>o</i> Nitrobenzene.	<i>m</i> Nitrobenzene.	<i>p</i> Nitrobenzene.
Water	20-25	0.21+	2.14+	1.32+
50% Aq. Pyridine	20-25	173	two layers formed	85.3
Pyridine	20-25	260	394	53.2

SOLUBILITY DATA, DETERMINED BY THE FREEZING-POINT METHOD (see footnote, p. 1), ARE GIVEN FOR MIXTURES OF NITROBENZENE AND EACH OF THE FOLLOWING COMPOUNDS:

Ethyl Ether	(Takalotos and Guye, 1910.)	Mercuric Bromide	(Mascarell and Ascoli, 1907.)
Hexane	(Timmermans, 1907, 1911.)	Mercuric Chloride	" "
Hexane + Resorcline	(Timmermans, 1907.)	Nitrosobenzene	(Jaeger and van Kregten, 1912.)
Isopentane	(Timmermans, 1910, 1911.)	Phenol	(Dahms, 1895.)
Diethyldiacetyl tartrate	(Scheuer, 1910.)	Ethylene Bromide	" "
Menthol	"	Naphthalene	(Kremann, '04; Kurnakov, <i>et al.</i> , '15.)

**DiNitroBENZENE (*m*) C<sub>6</sub>H<sub>4</sub>(NO<sub>2</sub>)<sub>2</sub>.**

**SOLUBILITY IN BENZENE, BROM BENZENE AND IN CHLOROFORM.**

"Synthetic Method."

(Schröder)

t°.	Gms. C <sub>6</sub> H <sub>4</sub> (NO <sub>2</sub> ) <sub>2</sub> per 100 Gms. Sol. in:			t°.	Gms. C <sub>6</sub> H <sub>4</sub> (NO <sub>2</sub> ) <sub>2</sub> per 100 Gms. Sol. in:		
	C <sub>6</sub> H <sub>6</sub> .	C <sub>6</sub> H <sub>5</sub> Br	CHCl <sub>3</sub> .		C <sub>6</sub> H <sub>6</sub> .	C <sub>6</sub> H <sub>5</sub> Br	CHCl <sub>3</sub> .
15	17.5	...	22.2	40	52.0	38.0	42.0
20	26.0	18.5	25.0	50	62.5	47.5	52.5
25	33.0	23.7	29.0	60	71.0	57.0	65.0
30	40.0	28.7	33.0	..	...	...	...

**SOLUBILITY OF *m* DINITROBENZENE IN SEVERAL ALCOHOLS AND ACIDS**

(Timofeiew, 1894.)

Solvent.	t°.	Gms. <i>m</i> C <sub>6</sub> H <sub>4</sub> (NO <sub>2</sub> ) <sub>2</sub> per 100 Gms.		Solvent.	t°.	Gms. <i>m</i> C <sub>6</sub> H <sub>4</sub> (NO <sub>2</sub> ) <sub>2</sub> per 100 Gms.	
		Sat. Sol.	Solvent.			Sat. Sol.	Solvent.
CH <sub>3</sub> OH	13.8	5.38	5.65	CH <sub>3</sub> COOH	15.5	15.7	18.6
C <sub>2</sub> H <sub>5</sub> OH	13.8	2.83	2.92	"	23	17.8	21.6
C <sub>3</sub> H <sub>7</sub> OH	13.8	2	2	C <sub>2</sub> H <sub>5</sub> COOH	13.5	12	13.6
C <sub>4</sub> H <sub>9</sub> OH	73	43.6	77.3	"	15.5	12.9	14.8
HCOOH	13.5	9	9.9	"	23	13.45	15.5
HCOOH	15.5	9.6	10.5	C <sub>3</sub> H <sub>7</sub> COOH	13.5	7.3	8.3
CH <sub>3</sub> COOH	13.5	15.2	17.9	"	15.5	8.2	8.9

100 gms. 95% formic acid dissolve 11.89 gms. *m* dinitrobenzene at 20.8°. (Aschan, '13.)

100 gms. pyridine dissolve 106.3 gms. *m* dinitrobenzene at 20°-25°. (Dehn, 1917.)

100 gms. 50% aq. pyridine dissolve 45.5 gms. *m* dinitrobenzene at 20°-25°.



**BENZIL**  $C_6H_5CO.COC_6H_5$ .

Data for the solubility of benzil in aqueous ethyl alcohol are given by Timmermans (1907) and by Kendall and Gibbons (1915). Data for aqueous solutions of benzil and phenol, for benzil and succinic acid nitrile and for benzil and ethyl amine are given by Timmermans (1907).

**SOLUBILITY DATA, DETERMINED BY THE FREEZING-POINT METHOD** (see footnote, p. 1), ARE GIVEN FOR THE FOLLOWING MIXTURES:

Benzil + Dibenzyl	(Vanstone, 1913.)
" + Azobenzene	"
" + Stilbene	"
" + Hydrobenzoin	"
" + Benzoin	(Beurath, 1912-13; Vanstone, 1909.)
" + Benzoic acid	(Kendall and Gibbons, 1915.)

**BENZINE** (Petroleum)  $C_6H_{12}C_8H_{14}$ .

100 parts of alcohol dissolve about 16 parts benzine of 0.638 — 660 Sp. Gr., at 25°.

**BENZOIC ACID**  $C_6H_5COOH$ .**SOLUBILITY IN WATER.**

(Bourgoin — Ann. chim. phys. [5] 15, 171, '78.)

t°.	Grams. $C_6H_5COOH$ per 100 Gms.		t°.	Grams. $C_6H_5COOH$ per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	0.170	0.170	40	0.555	0.551
10	0.210	0.209	50	0.775	0.768
20	0.290	0.289	60	1.155	1.142
25	0.345	0.343	80	2.715	2.643
30	0.410	0.408	100	5.875	5.549

100 grams saturated aqueous solution contain 0.25 gm.  $C_6H_5COOH$  at 15°; 0.3426 gram at 25°; 0.353 gram at 26.4°; 0.667 gram at 45°; 5.875 gms. at 100°.

(Paul, 1894; Noyes and Chapin, 1898; Greenish and Smith, 1903; Hoffman and Langbeck, 1905; Lumsden, 1905; Philip, 1905; see also Alexjew, 1886; Ost, 1878; Vaubel, 1895; Freundlich and Seal, 1912.)

**SOLUBILITY OF MIXTURES OF LIQUID BENZOIC ACID AND WATER.**

(Alexjew.)

Determinations by "Synthetic Method," see Note, p. 16. Figures read from curve.

t°.	Gms. $C_6H_5COOH$ per 100 Gms.		t°.	Gms. $C_6H_5COOH$ per 100 Gms.	
	Aq. Layer.	Benzoic Ac. Layer.		Aq. Layer.	Benzoic Ac. Layer.
70	6	83	100	12.0	69.0
80	7.5	79.5	110	18.0	59.0
90	8.5	76	116 (crit. temp.)	35	

**SOLUBILITY OF BENZOIC ACID IN AQUEOUS SOLUTIONS OF:**

(Hoffman and Langbeck.)

**Potassium Chloride at 25°.****Potassium Nitrate at 25°.**

Normality of Aq. KCl.	Gms. KCl per Liter.	Dissolved $C_6H_5COOH$ .		Normality of Aq. $KNO_3$ .	Gms. $KNO_3$ per Liter.	Dissolved $C_6H_5COOH$ .	
		Mol. Conc.	Wt. per cent.			Mol. Conc.	Wt. per cent.
0.02	1.49	$5.0254 \cdot 10^{-4}$	0.339	0.02	2.02	$5.0326 \cdot 10^{-4}$	0.340
0.05	3.73	4.9801	"	0.05	5.06	5.0421	"
0.20	14.92	4.7639	"	0.20	20.24	5.0297	"
0.50	37.30	4.3632	"	0.50	50.59	4.9400	"
				1.00	101.19	4.7646	"



SOLUBILITY OF BENZOIC ACID IN AQUEOUS SOLUTION  
(Hoffmann and Langbeck.)

Sodium Chloride.				Sodium Nitrate.		
Normality of Aq. NaCl.	Gms. NaCl per Liter.	Gms. C <sub>6</sub> H <sub>5</sub> COOH per 100 Gms. Sol.		Normality of Aq. NaNO <sub>3</sub> .	Gms. NaNO <sub>3</sub> per Liter.	Gm per at
		at 25°.	at 45°.			
0.00	0.00	0.340	0.667	0.02	1.70	0.3
0.02	1.17	0.339	0.663	0.05	8.51	0.3
0.05	2.93	0.335	0.654	0.20	17.02	0.3
0.20	11.70	0.336	0.617	0.50	42.54	0.3
0.50	29.25	0.282	0.546	1.00	85.09	0.2
1.00	58.50	...	0.449			

SOLUBILITY OF BENZOIC ACID IN AQUEOUS SOLUTIONS OF  
ACETATE, FORMATE, BUTYRATE, AND SALICYLATE  
(Noyes and Chapin — Z. physik. Chem. 27, 443, '98; Philip — J. Ch. Soc. 87, 99)

Grams Sodium Salt per Liter.	Grams C <sub>6</sub> H <sub>5</sub> COOH per Liter of Solution in:				
	CH <sub>3</sub> COONa.		HCOONa.		C <sub>6</sub> H <sub>5</sub> COONa. C <sub>6</sub> H
	At 25°.	At 26.4°.	At 25°.	At 26.4°.	
0	3.41	3.53	3.41	3.53	3.53
1	4.65	4.75	4.25	4.35	4.50
2	5.70	5.85	4.75	4.85	5.40
3	6.70	6.90	5.20	5.30	6.15
4	7.60	7.85	5.60	5.70	6.90
6	...	...	...	...	8.40
8	...	...	...	...	...

SOLUBILITY OF BENZOIC ACID IN AQUEOUS SOLUTIONS OF SODIUM  
CHLORACETATE, SODIUM SUCCINATE AND POTASSIUM FORMATE  
(Philip and Garner, 1909.)

In Aq. CH <sub>2</sub> ClCOONa.		In Aq. (CH <sub>2</sub> COONa) <sub>2</sub> .		In Aq. H	
Gms. per Liter Solution.		Gms. per Liter Solution.		Gms. per Lit	
CH <sub>2</sub> ClCOONa.	C <sub>6</sub> H <sub>5</sub> COOH.	(CH <sub>2</sub> COONa) <sub>2</sub> .	C <sub>6</sub> H <sub>5</sub> COOH.	HCOOK.	
0	3.38	0	3.38	0	
1.375	3.684	1.182	4.087	1.025	
3.426	4.026	2.932	5.112	2.563	
6.830	4.417	5.848	6.564	5.124	
13.710	4.929	11.730	9.005		

The authors also obtained data for the solubility of benzoic acid solutions of sodium acetate and sodium formate which agree closely quoted in the second table above.

100cc. 90% ethylalcohol dissolve 36.1 gms. C<sub>6</sub>H<sub>5</sub>COOH at 15.5°. (Greenis  
100 cc. of a 1.0 M aqueous solution of aniline hydrochloride dissolve  
C<sub>6</sub>H<sub>5</sub>COOH at 25°. (S

SOLUBILITY OF BENZOIC ACID IN AQUEOUS SOLUTIONS OF ETHYL  
AT 25°.

(Seidell, 1908, 1910.)

Wt. % C <sub>6</sub> H <sub>5</sub> OH in Solvent.	Sp. Gr. of Sat. Sol.	Gms. per 100 Gms. Sat.		Wt. % C <sub>6</sub> H <sub>5</sub> OH in Solvent.	Sp. Gr. of Sat. Sol.	Gms. per
		C <sub>6</sub> H <sub>5</sub> OH.	C <sub>6</sub> H <sub>5</sub> COOH.			C <sub>6</sub> H <sub>5</sub> OH.
0	1	0	0.507	60	0.943	45.72
10	0.985	0.04	0.60	70	0.940	49.21
20	0.970	10.00	1.70	80	0.934	52.8
30	0.950	28.83	3.00	90	0.922	57.6
40	0.931	30.30	0.10	100	0.908	63.1
50	0.940	41.50	17			



SOLUBILITY OF BENZOIC ACID IN 90% ALCOHOL, IN ETHER AND IN CHLOROFORM.  
(Bourgoin.)

Solvent.	t°.	Gms. C <sub>6</sub> H <sub>5</sub> COOH per 100 Grams.	
		Solvent.	Solution.
90% Alcohol	15	41.62	29.39
Ether	15	31.35	23.86
Chloroform	25	14.30	12.50

SOLUBILITY OF BENZOIC ACID IN SEVERAL ALCOHOLS. (Timofeiew, 1894.)

Alcohol.	t°.	Gms. C <sub>6</sub> H <sub>5</sub> COOH per 100 Gms.		Alcohol.	t°.	Gms. C <sub>6</sub> H <sub>5</sub> COOH per 100 Gms.	
		Sat. Sol.	Solvent.			Sat. Sol.	Solvent.
Methyl	-18	23.1	30	Propyl	-18	14.5	16.9
"	-13	24.3	32.1	"	-13	15.7	18.5
"	+3	33.5	50.4	"	+3	23.1	30
"	19.2	40.1	67.1	"	19.2	28.2	39.3
"	23	41.7	71.5	"	23	29.8	42.3
Ethyl	-18	20.3	25.4	Isopropyl	21.2	32.7	48.5
"	-13	21.2	26.9	Allyl	21.2	25.1	33.4
"	+3	28.8	40.4	Isobutyl	0	15.3	18
"	19.2	34.4	52.4	Isoamyl	18	20.2	25.4
"	23	35.9	55.9	Caprylic	21.2	22.7	28.7
				Ethyleneglycol	18	8	8.69

Additional data, agreeing closely with the above, are given by Timofeiew (1891) and Bourgoin (1878).

SOLUBILITY OF BENZOIC ACID IN AQUEOUS SOLUTIONS OF DEXTROSE.  
(Hoffman and Langbeck.)

Normality of Aq. Dextrose.	Gms. C <sub>6</sub> H <sub>5</sub> O <sub>6</sub> per Liter.	Dissolved C <sub>6</sub> H <sub>5</sub> COOH at 25°.		Dissolved C <sub>6</sub> H <sub>5</sub> COOH at 45°.	
		Mol. Conc.	Weight Per Cent.	Mol. Conc.	Weight Per Cent.
0.02	3.67	5.0322 · 10 <sup>-4</sup>	0.34	9.9088 · 10 <sup>-4</sup>	0.674
0.05	9.00	5.0403 "	0.34	9.9328 "	0.669
0.204	36.73	5.0303 "	0.34	9.9323 "	0.669
0.533	96.15	5.0321 "	0.34	10.0101 "	0.674
1.068	192.30	5.0443 "	0.341	10.0369 "	0.676

SOLUBILITY OF BENZOIC ACID IN AQUEOUS SOLUTIONS OF UREA AND OF THIO UREA.  
(Hoffman and Langbeck.)

	Normality of Solution.	Gms. per Liter.	C <sub>6</sub> H <sub>5</sub> COOH Dissolved at 25°.	
			Mol. Conc.	Wt. per cent.
In Aqueous Urea	0.10	6.01 CO(NH <sub>2</sub> ) <sub>2</sub>	5.1876 · 10 <sup>-4</sup>	0.350
In Aqueous Thio Urea	0.20	15.23 CS(NH <sub>2</sub> ) <sub>2</sub>	5.4994 "	0.372

Data for the system benzoic acid, succinic acid nitrile and water are given by Schreinemakers, 1898, and for the system benzoic acid, phenol and water by Timmermanns, 1907.

SOLUBILITY OF BENZOIC ACID IN BENZENE AND VICE VERSA. (Roloff, 1895.)

t°.	Gms. C <sub>6</sub> H <sub>5</sub> COOH per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. C <sub>6</sub> H <sub>5</sub> COOH per 100 Gms. Sat. Sol.	Solid Phase.
5.37	0	C <sub>6</sub> H <sub>6</sub>	20	8.8	C <sub>6</sub> H <sub>5</sub> COOH
5	1.75	"	30	13	"
4.50	3.95	"	50	25	"
4.20	5	C <sub>6</sub> H <sub>6</sub> + C <sub>6</sub> H <sub>5</sub> COOH	70	43.5	"
5	5.05	C <sub>6</sub> H <sub>5</sub> COOH	90	64	"
7	5.50	"	110	91.5	"
9	5.70	"	121	100	"
11	6	"			

Von Euler and Löwenhamm (1916) found 7.76 gms. C<sub>6</sub>H<sub>5</sub>COOH per 100 cc. of sat. solution in benzene at 25°, and 7.76 gms. C<sub>6</sub>H<sub>5</sub>COOH + 2.50 gms. C<sub>6</sub>H<sub>5</sub>OHCOOH per 100 cc. of benzene solution saturated with both acids.



SOLUBILITY OF BENZOIC ACID IN ORGANIC SOLVENTS.

Solvent.	t°.	Gms. $\text{C}_6\text{H}_5\text{COOH}$ per 100 cc. Sat. Sol.	Solvent.	t°.	$\frac{g}{100 \text{ cc.}}$ of Sat. Solution.
Aq. 75% Acetic Acid	14-16	10.92 (1)	Amyl Alcohol	25	0.875
Benzene	14-16	7.04 (1)	Amyl Acetate	25	0.912
Carbon Disulfide	14-16	4.24 (1)	Alcohol (Abs.)	25	0.908
Carbon Tetrachloride	14-16	4.50 (1)	Benzene	25	0.897
"	25	6.70 (2)	Chloroform	25	1.456
"	26	6.58 (3)	Carbon Tetrachloride	25	1.564
Chloroform	25	18.03 (2)	Carbon Disulfide	25	1.282
Ethyl Ether	14-16	39.80 (1)	Cumene	25	0.906
Glycerol	15-16	9.07* (4)	Ethyl Ether (Abs.)	25	...
Ligroin	14-16	0.72 (1)	Ligroin	25	0.720
Petroleum Ether †	26	0.98 (3)	Naphtha	25	0.730
Pentachlor Ethane	25	10.92 (2)	Nitrobenzene	25	1.225
Tetrachlor Ethane	25	15.17 (2)	Toluene	25	0.884
Tetrachlor Ethylene	25	8.06 (2)	Spts. Turpentine	25	0.859
Trichlor Ethylene	25	13.62 (2)	Water	25	1
"	15	6.44* (5)	Xylene	25	0.877
Dichlor Ethylene	15	9.67* (5)			

\* = Gms.  $\text{C}_6\text{H}_5\text{COOH}$  per 100 gms. sat. sol. † (B. pt. 30-70.)

(1) Bornwater and Holleman (1912); (2) Herz and Rathmann (1913); (3) de Jong (1909); (4) Dowaki (1907); (5) Wester and Bruins (1914); (6) Seidell (1910).

One liter sat. sol. of benzoic acid in ethyl acetate contains 8 gms. at 37.7 gms. at 21.5° and 95.7 gms. at 75°.

SOLUBILITY OF BENZOIC ACID IN MIXTURES OF ORGANIC SOLVENTS.  
(Marden and Dover, 1916.)

Mixtures of Ether + Chloroform.		Mixtures of Acetone + Benzene.		Mixtures of Ethyl Ether + Benzene.	
% $\text{CHCl}_3$ in Solvent.	Gms. $\text{C}_6\text{H}_5\text{COOH}$ per 100 Gms. Solvent.	% $\text{C}_6\text{H}_6$ in Solvent.	Gms. $\text{C}_6\text{H}_5\text{COOH}$ per 100 Gms. Solvent.	% $\text{C}_6\text{H}_6$ in Solvent.	Gms. $\text{C}_6\text{H}_5\text{COOH}$ per 100 Gms. Solvent.
100	38.4	100	11.6	100	1
90	34	90	18.3	90	1
80	30.1	80	24.1	80	1
70	26.6	70	31	70	2
60	23.2	60	33.5	60	2
50	20.8	50	37	50	2
40	18.6	40	42.2	40	2
30	16.8	30	47	30	2
20	15.6	20	49	20	2
10	15.2	10	51.3	10	2
0	15.0	0	55.6	0	4

\* This is probably a mistake in the original and should be  $\%(\text{C}_6\text{H}_5)_2\text{O}$  in Solvent.

SOLUBILITY DATA, DETERMINED BY THE FREEZING-POINT METHOD (see p. 1), ARE GIVEN FOR MIXTURES OF BENZOIC ACID AND EACH OF THE FOLLOWING COMPOUNDS:

Chlorobenzoic Acid	(Bornwater and Holleman, 1912.)	Piperonal	(Kendall and Gibbs, 1914.)
"	"	Pyridine	(Baskov, 1914.)
"	"	Salicylic Acid	(Jaeger, 1907.)
Nitrobenzoic Acid	(Bakunin and Angerani, 1915.)	Succinic Acid Nitrile	(Schreinemakers, 1915.)
Benzil	(Kendall and Gibbs, 1915.)	Sulfuric Acid	(Kendall and Carpe, 1914.)
Camphor	(Journé, 1912.)	Toluic Acid	(Kendall, 1914.)
Cinnamic Acid	(Kachler 1898; Kendall, 1914.)	Toluidine	(Baskov, 1913.)
Dimethylpyrone	(Kendall, 1914.)	"	(Baskov, 1913; Vig, 1911.)
Fluorobenzoic Acid	(Kachler, 1911.)		



## DISTRIBUTION OF BENZOIC ACID BETWEEN WATER AND BENZENE:

t°. (1897.)	At 20°. (Nernst, 1891.)			At 25°. (Farmer, 1903.)		At 40°. (Hendrixon, 1897.)	
	Gms. C <sub>6</sub> H <sub>5</sub> COOH per 100 cc.			Gms. C <sub>6</sub> H <sub>5</sub> COOH per 100 cc.		Gms. C <sub>6</sub> H <sub>5</sub> COOH per 100 cc.	
	C <sub>6</sub> H <sub>6</sub> Layer.	H <sub>2</sub> O. Layer.	C <sub>6</sub> H <sub>6</sub> Layer.	H <sub>2</sub> O Layer.		H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>6</sub> Layer.
0.0725	0.0163	0.0535	0.2002	(0.1885*)	3.335	0.0238	0.0714
0.2363	0.0244	0.099	0.2012	(0.1891*)	3.329	0.0404	0.1637
0.4422	0.0452	0.273	0.2020	(0.1902*)	3.319	0.0837	0.5740
1.0889	0.0788	0.737				0.1155	1.0269
2.0272	0.1500	2.42				0.1715	2.1420
2.7426	0.2890	9.70				0.2313	3.9167

\* = unionised.

DISTRIBUTION OF BENZOIC ACID BETWEEN BENZENE AND AQUEOUS  
POTASSIUM BENZOATE SOLUTIONS AT 25°.

(Farmer, 1903.)

Gm. K per Sol.	Gm. Mols. C <sub>6</sub> H <sub>5</sub> COOH per Liter.		Gms. C <sub>6</sub> H <sub>5</sub> COOK per Liter Aq. Sol.	Gms. C <sub>6</sub> H <sub>5</sub> COOH per liter.	
	Aq. Layer.	C <sub>6</sub> H <sub>6</sub> Layer.		Aq. Layer.	C <sub>6</sub> H <sub>6</sub> Layer.
93	0.01587	0.2776	1.341	1.937	33.88
8	0.01597	0.2768	4.035	1.950	33.79
7	0.01603	0.2762	6.774	1.956	33.71

## DISTRIBUTION OF BENZOIC ACID BETWEEN:

Water and Chloroform. (Hendrixon, 1897.)      Water and CCl<sub>4</sub>. (Seidell, 1902a.)

At 10°.		At 40°.		At 25°.	
Gms. C <sub>6</sub> H <sub>5</sub> COOH per 100 cc.		Gms. C <sub>6</sub> H <sub>5</sub> COOH per 100 cc.		Gms. C <sub>6</sub> H <sub>5</sub> COOH per 100 cc.	
W <sub>2</sub> Layer.	C <sub>6</sub> H <sub>6</sub> Layer.	H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>6</sub> Layer.	H <sub>2</sub> O Layer.	CCl <sub>4</sub> Layer.
108	0.0915	0.0258	0.0880	0.134	0.830
169	0.1518	0.0432	0.2059	0.291	4.41
127	0.2170	0.0885	0.6961		
157	2.0930	0.1553	2.0435		

coefficient of distribution of benzoic acid between olive oil and water at 15° given by Boeseken and Waterman (1911) as 12.6.

BENZOIC ACID (o) C<sub>6</sub>H<sub>4</sub>NH<sub>2</sub>COOH.

## SOLUBILITY OF o AMINOBENZOIC ACID IN WATER. (Lunden, 1905-06.)

t°.	Sp. Gr. Sat. Sol.	Gms. C <sub>6</sub> H <sub>4</sub> NH <sub>2</sub> COOH(o) per 100 cc. Sat. Sol.	t°.	Sp. Gr. Sat. Sol.	Gms. C <sub>6</sub> H <sub>4</sub> NH <sub>2</sub> COOH(o) per 100 cc. Sat. Sol.
0	0.999	0.519	34.9	0.998	0.731
1	...	0.540	35	0.997	0.744
1	...	0.570	39.8	0.997	0.889

SOLUBILITY OF o AMINOBENZOIC ACID IN AQUEOUS SALT SOLUTIONS AT 25°.  
(Lunden, 1905-06.)

Salinity of Salt Solution.	Sp. Gr. Sat. Solution.	Gms. C <sub>6</sub> H <sub>4</sub> NH <sub>2</sub> COOH(o) per 100 cc. Sat. Solution.	Normality of Salt Solution.	Sp. Gr. Sat. Solution.	Gms. C <sub>6</sub> H <sub>4</sub> NH <sub>2</sub> COOH(o) per 100 cc. Sat. Sol.
1/2 Ba(NO <sub>3</sub> ) <sub>2</sub>	1.080	0.634	2.633 KNO <sub>3</sub>	1.155	0.501
"	1.052	0.603	1.372 "	1.083	0.544
"	1.037	0.585	0.598 "	1.033	0.549
"	1.018	0.555	1.853 KI	1.221	0.541
"	1.015	0.549	0.946 "	1.114	0.559
			0.560 "	1.068	0.556

The author also gives additional data for aqueous salt solutions at 28.1°. Additional data for the solubility of aminobenzoic acid in aqueous salt solutions given by Euler (1916).



AminoBENZOIC ACID  $C_6H_4NH_2COOH$  (*m*).

## SOLUBILITY IN WATER AND IN OTHER SOLVENTS.

(de Coninck — Compt. rend. 116, 758, '93.)

In Water.		In Organic Solvents.		
t°.	Gms. $C_6H_4NH_2COOH(m)$ per 100 cc. $H_2O$ .	Solvent.	t°.	Gms. $C_6H_4NH_2COOH(m)$ per 100 cc. Solvent
0	0.43	Ethyl Alcohol (95%)	12.5	2.92
10	0.52	Methyl Alcohol (pure)	10.5	4.05
20	0.67	Acetone	11.3	6.22
30	0.87	Methyl Iodide	10.0	0.04
40	1.15	Ethyl Iodide	0.0	0.02
50	1.50	Chloroform	12.0	0.07
60	2.15	Bromoform	8.0	trace
70	3.15			

## MUTUAL SOLUBILITY OF AMINOBENZOIC ACIDS AND WATER AT HIGH TEMPERATURES, DETERMINED BY THE SYNTHETIC METHOD.

(Flaschner and Rankin, 1910.)

Mixtures of <i>o</i> Acid and $H_2O$ .		Mixtures of <i>m</i> Acid and $H_2O$ .		Mixtures of <i>p</i> acid and $H_2O$ .	
t° of Melting.	Gms. <i>o</i> Acid per 100 Gms. Mixture.	t° of Melting.	Gms. <i>m</i> Acid per 100 Gms. Mixture.	t° of Melting.	Gms. <i>p</i> Acid per 100 Gms. Mixture.
83.6	4.8	66 crit. sol. temp.		47 crit. sol. temp.	
95.8	9.9	77.8	4.6	82.2	5
101.4	18.5	90	5.8	90	7.1
103.4	30.6	100	9.7	100	15.8
104.4	38	110	20.2	105	22
105	49.4	120	51.2	110	32.3
105.6	59.4	130	73.7	116	51.8
107.8	69.7	140	83.7	120	62
112	80	150	90.7	130	77
116.2	87.2	160	95.8	150	91.1
128.4	95	170	99.2	170	98
144.6	100	174.4	100	186	100

t° reading, for critical saturation and for separating, also given in the case of the *o* acid.

Data for the distribution of *o* aminobenzoic acid between water and benzene at 25° are given by Farmer and Warth (1904).

AminonitroBENZOIC ACIDS  $C_6H_3NO_2NH_2COOH$  *o*, *m* and *p*.

## SOLUBILITY OF THE THREE ISOMERIC AMINONITROBENZOIC ACIDS:

In Ether.				In Ethyl Alcohol (90%).			
t°.	Gms. $C_6H_3NO_2NH_2COOH$ per 100 cc. Ether.			t°.	Gms. $C_6H_3NO_2NH_2COOH$ per 100 cc. Alcohol.		
	Ortho.	Meta.	Para.		Ortho.	Meta.	Para.
2.7	10.84	1.70	6.41	3	8.13	1.79	8.1
5.8	10.05 (0.8°)	1.81	8.21	9.6	10.70	2.20	11.1

## SOLUBILITY IN WATER OF THE THREE ISOMERIC:

(Vaubel, 1895.)

Aminobenzo Sulphonic Acids.				Amino Phenols.			
t°.	G. $C_6H_3NH_2SO_3H$ per 100 G. Aq. Sol.			t°.	G. $C_6H_3(OH)NH_2$ per 100 G. Aq. Sol.		
	Ortho.	Meta.	Para.		Ortho.	Meta.	Para.
7	1.00	1.270	0.502 (0°)	0	1.7	2.6 (20°)	1.1



## 1. Chlor and IodoBENZOIC ACIDS.

SOLUBILITY IN WATER AT 25°. (Paul, 1894; Löwenherz, 1898; Vaubel, 1895.)

Compound.	Formula.	Per 1000 cc. Aqueous Solution.	
		Grams.	Gram Mol.
Orthobromobenzoic Acid	$C_6H_4Br.COOH$ (ortho)	1.856	0.00924
Metabromobenzoic Acid	$C_6H_4Br.COOH$ (meta)	0.402	0.00200
Parabromobenzoic Acid	$C_6H_4Br.COOH$ (para)	0.056	0.00028
Orthochlorobenzoic Acid	$C_6H_4Cl.COOH$ (ortho)	2.087	0.01333
Orthoiodobenzoic Acid	$C_6H_4I.COOH$ (ortho)	0.952	0.00384
Metaiodobenzoic Acid	$C_6H_4I.COOH$ (meta)	0.116	0.00047
Paraiodobenzoic Acid	$C_6H_4I.COOH$ (para)	0.027	(Koopal, 1912.)

The following results at 28°. (Sieger, 1912.)

Orthochlorobenzoic acid	$C_6H_4ClCOOH$ (ortho)	2.25	...
"	" (meta)	0.45	...
"	" (para)	0.093	...

## RELATIVE SOLUBILITY OF BROMO AND CHLOROBENZOIC ACIDS AND WATER AT HIGH TEMPERATURES, DETERMINED BY SYNTHETIC METHOD. (Flaschner and Rankin, 1910.)

Temp. of Acid + Water.	o Chlorobenzoic Acid + Water.		m Chlorobenzoic Acid + Water.		p Chlorobenzoic Acid + Water.	
	Gms. Acid per 100 Gms. Mixture.	t° of Melting.	Gms. Acid per 100 Gms. Mixture.	t° of Melting.	Gms. Acid per 100 Gms. Mixture.	t° of Melting.
70 (crit. sol. temp.)	100.8	100.8	5.5	123	4.2	167 (crit. t.)
80	3	102.7	10	123.8	18.9	162
80	6.2	104	20	142.8 (crit. t.)	34.3	170
90	10.5	126.2 (crit. t.)	34.9	123.8	75.8	180
106	27	104	76	125	81.5	183
100	61	110	85.3	130	87.5	184
110	80	120	92	140	93.2	187
120	88.3	130	96.5	150	97.5	200
140	96.9	139.5	100	156	100	220
154	100					240

## SOLUBILITY OF ORTHOCHLOROBENZOIC ACID IN AQUEOUS SOLUTIONS OF SODIUM ACETATE, SODIUM FORMATE AND POTASSIUM FORMATE AT 25°. (Philip and Garner, 1909.)

In Aq. $CH_3COONa$ .		In Aq. $HCOONa$ .		In Aq. $HCOOK$ .	
Grams per Liter.		Grams per Liter.		Grams per Liter.	
$CH_3COONa$	$C_6H_4ClCOOH$	$HCOONa$	$C_6H_4ClCOOH$	$HCOOK$	$C_6H_4ClCOOH$
1.009	3.599	0.843	3.381	0	2.128
2.484	6.181	2.102	5.258	1.025	3.396
5.027	15.60	4.196	7.637	2.563	5.226
10.07	18.27	8.410	11.02	5.124	7.543

## SOLUBILITY OF CHLOROBENZOIC ACIDS IN SEVERAL SOLVENTS AT 14-16°. (Bornwater and Holleman, 1912.)

Solvent.	Gms. per 100 cc. Sat. Solution.		
	o $C_6H_4ClCOOH$ .	m $C_6H_4ClCOOH$ .	p $C_6H_4ClCOOH$ .
Ligroin	0.07	0.084	trace
Carbon Tetrachloride	0.58	0.48	0.04
Benzene	0.92	0.66	0.017
Carbon Disulfide	0.52	0.62	0.016
75% Aq. Acetic Acid	6.22	...	0.32
Ethyl Ether	16.96	14	1.72
Acetone	28.42	...	2.58
Ethyl Acetate	13.20	...	1.64

Freezing-point data are given by Bornwater and Holleman (1912) for mixtures of o, m and p chlorobenzoic acids.



# BENZOIC ACIDS

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## FluoroBENZOIC ACIDS $C_6H_4FCOOH$ .

100 cc. aqueous solution saturated at 32° contain 0.882 gm. *o*  $C_6H_4F.COOH$ .  
 " " " " " " 0.308 " *m* "  
 " " " " " " 0.107 " *p* "

(Slothower, 1924.)

## IodoBENZOIC ACID $p$ $C_6H_4ICOOH$ .

### MUTUAL SOLUBILITY OF PARA IODOBENZOIC ACID AND WATER AT HIGH TEMPERATURES DETERMINED BY THE SYNTHETIC METHOD. (Flaschner and Rankin, 1910.)

t° of Melting.	Gms. Acid per 100 Gms. Mixture.	t° of Melting.	Gms. Acid per 100 Gms. Mixture.	t° of Melting.	Gms. Acid per 100 Gms. Mixture.
175 crit. sol. t.		207	22	230	87.4
178	3	210	41	240	92.7
190	5.8	215	63.5	269	98.1
200	10	220	77	270	100

## *p* Iodo Bromo and ChloroBENZOIC ACID Methyl Esters.

FREEZING-POINT DATA (Solubility, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES.  
 (Jaeger, 1906.)

*p* Chlorobenzoic methyl ester + *p* Bromobenzoic methyl ester.  
 " " " + *p* Iodobenzoic " "  
*p* Iodobenzoic " " + *p* Bromobenzoic " "

## HexahydroBENZOIC ACID $CH_2(CH_2CH_2)_3.CH.COOH$ .

100 gms.  $H_2O$  dissolve 0.201 gm. of the acid at 15°, *d.* saturated solution = 1.048.  
 (Lumsden, 1905.)

## HydroxyBENZOIC ACIDS *m* and *p* (*o* = Salicylic Acid, see p. 588).

### SOLUBILITY OF META AND PARA HYDROXYBENZOIC ACIDS IN WATER, BENZENE, ETC. (Walker and Wood, 1898.)

In Water.			In Benzene.	
t°.	Gms. $C_6H_4.OH.COOH$ per 100 Gms. $H_2O$ .		Gms. $C_6H_4.OH.COOH$ per 100 Gms. $C_6H_6$ .	
	Meta.	Para.	Meta.	Para.
10	0.55	0.25	...	0.0018
20	0.90	0.50	0.008	0.0027
25	1.08	0.65	0.010	0.0035
30	1.34	0.81	0.012	0.0045
35	1.64	1.01	0.015	0.0060
40	2.10	1.24	0.017	0.0082
50	3.10	2.12	0.028	0.0162
60	...	...	0.047	0.028
80	...	...	...	0.066

In Acetone.			In Ether.	
t°.	G. $C_6H_4.OH.COOH$ per 100 cc. Sol.		t°.	G. $C_6H_4.OH.COOH$ per 100 cc. Sol.
	Meta.	Para.		Meta. Para.
23	26.0	22.7	17	9.73 9.43

100 gms. sat. sol. in  $H_2O$  contain 0.7 gm. *m* acid at 15° and 4 gms. at 50°.

" " " " " 0.44 " *p* " " " 2.98 " " "  
 " " "  $CH_3OH$  " 53.58 " *m* " " "  
 " " " " " 236.22 " *p* " " "  
 " 95% formic acid dissolve 2.37 gms. *m* acid at 20.8°. (Savorro, 1924.)  
 (Aschan, 1915.)



**MUTUAL SOLUBILITY OF META AND PARA OXYBENZOIC ACIDS AND WATER AND OF PARAMETHOXYBENZOIC ACID AND WATER AT HIGH TEMPERATURES, DETERMINED BY THE SYNTHETIC METHOD.**

(Flaschner and Rankin, 1910.)

Meta Oxybenzoic Acid +H <sub>2</sub> O.		Para Oxybenzoic Acid +H <sub>2</sub> O.		Para Methoxybenzoic Acid + H <sub>2</sub> O.	
t° of Melting.	Gms. Acid per 100 Gms. Mixture.	t° of Melting.	Gms. Acid per 100 Gms. Mixture.	t° of Melting.	Gms. Acid per 100 Gms. Mixture.
78.2	9.9	77	10	138.2	crit. sol. t.
90.8	20	90	19.8	140	9
98	30	97.4	29.5	142	12
103.2	39.8	104.4	40.1	144	18
108.8	49	111.8	50	145	30
119.2	60	120	59.6	146	59.4
131.4	70	134	69.2	150	73.3
143.4	77.9	154.4	80	160	89.8
175.6	90.8	180.6	90.4	170	95.6
199.8	100	213	100	184	100

Readings for t° of critical saturation obtained by cooling from t° of melting, are also given by the authors.

Coefficients of distribution of oxybenzoic acids between water and olive oil are given by Boeseken and Waterman (1911) as follows: *p* oxybenzoic acid, 0.6; *m* oxybenzoic acid, 0.4; 2,4 dioxibenzoic acid, 1.0; 2,5 dioxibenzoic acid, 0.3; 3,4 dioxibenzoic acid, 0.05; 3,4,5 trioxybenzoic acid 0.025.

**MethylBENZOIC ACIDS** C<sub>6</sub>H<sub>4</sub>COOH.CH<sub>3</sub>. *o*, *m*, and *p*.

**SOLUBILITY IN WATER.**

(Vaubel, 1895.)

t°.	Gms. C <sub>6</sub> H <sub>4</sub> COOH.CH <sub>3</sub> per 1000 Gms. Sat. Solution.		
	Ortho.	Meta.	Para.
25	1.18	0.98	0.35

**NitroBENZOIC ACIDS** C<sub>6</sub>H<sub>4</sub>.NO<sub>2</sub>.COOH. *o*, *m*, and *p*.

**SOLUBILITY IN SEVERAL SOLVENTS.**

(*o*: Connick, 1894; for solubility in H<sub>2</sub>O, see also Paul; Vaubel; Löwenherz; Goldschmidt, 1898; Holleman, 1898; Noyes and Sammet, 1903; Sidgwick, 1910.)

Solvent.	t°.	Gms. C <sub>6</sub> H <sub>4</sub> .NO <sub>2</sub> .COOH per 100 cc. Solvent.		
		Ortho.	Meta.	Para.
Water	15	0.625	0.238	0.0213
"	20	0.682 (0.645G.)	0.315	0.039
"	25	0.738 (0.779G.)	0.341	0.028 (0.045)
"	30	0.922 (0.922G.)	...	...
"	35	1.141 (1.054)	0.477	0.0419
Methyl Alcohol	10	42.72	47.34	9.6
Ethyl Alcohol	10	28.2	33.1 (11.7°)	0.9
" (abs.)	15	37.58*	47.26*	19.71*
" (33 Vol.%)	15	0.64 (11.8°)	0.52	0.055
Acetone	10	41.5	41.5	4.54
Benzene	10	0.204	0.795	0.017 (12.5°)
Carbon Disulfide	10	0.012	0.10 (8.5°)	0.007
Chloroform	10	0.455 (11°)	5.678	0.066
"	15	1.06†	3.45†	0.088†
"	25	1.13†	4.7†	0.114†
"	35	1.59†	6.31†	0.156†
Ether	10	21.58	25.175	2.26
Ligroin	10	trace	0.013	0

\* = Gms. acid per 100 cc. saturated solution.

† = Gms. acid per 100 gms. solvent.



## SOLUBILITY OF ORTHO NITROBENZOIC ACID IN WATER. (Noyes and Samm

t°.	C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> COOH <i>o</i> per Liter Sol.		t°.	C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> COOH <i>o</i> per	
	Millimols.	Grams.		Millimols.	G
10	26.62	4.645	25	43.3	7
15	31.06	5.187	30	51.6	8
20	36.57	6.106			

Additional determinations by other investigators, in millimols C<sub>6</sub>H<sub>4</sub>N(*o*) per liter at 25°, are: 46.5 (van Maarseveen, 1898); 44.19 (Paul, 189 (Holleman, 1898); 43.6 (Kendall, 1911).

## SOLUBILITY OF ORTHO, META AND PARA NITROBENZOIC ACIDS IN V AT HIGH TEMPERATURES, DETERMINED BY THE SYNTHETIC METH (Flaschner and Rankin, 1910.)

<i>o</i> C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> COOH + H <sub>2</sub> O.			<i>m</i> C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> COOH + H <sub>2</sub> O.			<i>p</i> C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> COOH		
t° of Melting.	Gms. Acid per 100 Gms. Sat. Sol.	t° of: Melting.	Solution*		Gms. Acid per 100 Gms. Sat. Sol.	t° of Melting.	G	per
52 crit. t.	...	63.2	...		2	118 crit. t.		
69	5	77.4	...		6	143		
75	9.9	77.4	90		7	150		
78	13.5	77.4	100		10.5	155		
79	49.5	77.4	105		17	160		
80	62	77.4	107.5 crit. t.		30	165		
85	73.5	77.4	106		50	170		
90	78.6	77.4	100		58.6	180		
100	83.5	77.4	90		65.4	190		
120	94	80	...		74	200		
148	100	100	...		88.5	220		
		120	...		96.8	237		1
		140.4	...		100			

Data for the solubility of mixtures of *o*, *m* and *p* nitrobenzoic acids in 24.4° are given by Holleman (1898).

## SOLUBILITY OF ORTHO NITROBENZOIC ACID IN AQUEOUS SOLUTIONS OF CHLORIC, FORMIC, MALONIC AND SALICYLIC ACIDS AT 25°. (Kendall,

Solvent.	Normality of Solvent.	Gms. <i>o</i> C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> COOH per Liter Sat. Solution.	Solvent.	Normality of Solvent.	G
HCl	0.0179	6.146	CH <sub>2</sub> (COOH) <sub>2</sub>	0	7
"	0.0357	5.661	"	0.0313	7
"	0.125	4.976	"	0.1001	6
"	0.250	4.997	"	0.2004	6
"	0.500	4.752	C <sub>6</sub> H <sub>4</sub> (OH)COOH	0.0094	7
HCOOH	0.0517	7.188	"	0.0136	7
"	0.0998	7.124	"	0.0162	7

## SOLUBILITY OF ORTHO NITROBENZOIC ACID IN AQUEOUS SOLUTION: DEXTROSE, SODIUM CHLORIDE, AND OF SODIUM NITRATE.

Original results in molecular quantities. (Hoffman and Langbeck, 1905

In Dextrose.			In NaCl.			In NaNO <sub>2</sub> .		
G. C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> per 100 cc. Solution.	G.( <i>o</i> )C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> COOH per 100 g. Solvent. At 25°.	At 35°.	G. NaCl. per 100 cc. Solution.	G.( <i>o</i> )C <sub>6</sub> H <sub>4</sub> NO <sub>2</sub> COOH per 100 g. Solvent. At 25°.	At 35°.	G. NaNO <sub>2</sub> per 100 cc. Solution.	G.( <i>o</i> )C <sub>6</sub> H <sub>4</sub> N per 100 g. At 25°.	At 35°.
0.0	0.736	1.063	0.117	0.743	1.072	0.170	0.746	1
0.36	0.736	1.064	0.195	0.746	1.075	0.284	0.754	1
1.80	0.732	1.061	0.585	0.749	1.070	0.851	0.767	1
9.50	0.722	1.051	2.425	0.688	0.967	4.255	0.774	1
20.00	0.703	1.030	5.80	0.597	0.831	8.510	0.748	1



SOLUBILITY OF ORTHO NITROBENZOIC ACID IN AQUEOUS SOLUTIONS OF  
SODIUM BUTYRATE, ACETATE, FORMATE, AND SALICYLATE AT 26.4°.

(Philip, 1905.)

Original results in terms of  $\frac{\text{Mols.}}{100}$  per liter.

Gms. Na Salt per Liter.	Gms. Ortho $\text{C}_6\text{H}_4\text{COOH.NO}_2$ per Liter of Solution in:			
	$\text{C}_3\text{H}_7\text{COONa.}$	$\text{CH}_3\text{COONa.}$	$\text{HCOONa.}$	$\text{C}_6\text{H}_4\text{OH.COONa.}$
0	7.85	7.85	7.85	7.85
0.5	8.35	8.50	8.60	8.35
1.0	8.90	9.15	9.50	8.70
2	10.0	10.80	11.5	9.4
3	11.2	12.55	13.5	11.0
4	12.4	14.5	15.6	11.5
6	15.2	...	...	...

SOLUBILITY OF ORTHO NITROBENZOIC ACID IN SEVERAL ALCOHOLS.

(Timofeiew, 1894.)

Solvent.	t°.	Gms. Acid per 100 Gms.		Solvent.	t°.	Gms. Acid per 100 Gms.	
		Sat. Sol.	Solvent.			Sat. Sol.	Solvent.
$\text{CH}_3\text{OH}$	0	36.2	56.6	$\text{C}_2\text{H}_7\text{OH}$	0	17.7	21.5
"	22	52.2	109.1	"	22	31.2	45.5
$\text{C}_2\text{H}_5\text{OH}$	0	23.3	30.4	$(\text{CH}_3)_2\text{CH.CH}_2\text{OH}$	0	9.65	10.7
"	22	42.7	74.5				

Freezing-point data for mixtures of *o* nitrobenzoic acid and dimethylpyrone are given by Kendall (1914a).

SOLUBILITY OF META NITROBENZOIC ACID IN SEVERAL ALCOHOLS.

(Timofeiew, 1894.)

Solvent.	t°.	Gms. Acid per 100 Gms.		Solvent.	t°.	Gms. Acid per 100 Gms.	
		Sat. Sol.	Solvent.			Sat. Sol.	Solvent.
$\text{CH}_3\text{OH}$	0	41.9	72.2	$\text{C}_2\text{H}_5\text{OH}$	21.5	43.9	89.8
"	19	53.7	116	$\text{C}_2\text{H}_7\text{OH}$	0	24.1	31.8
"	21.5	57.1	133.1	"	19	31	45
$\text{C}_2\text{H}_5\text{OH}$	0	33.6	50.6	"	21.5	32.5	48
"	19	42.3	73.2				

SOLUBILITY OF META NITROBENZOIC ACID IN AQUEOUS SOLUTIONS OF SODIUM  
ACETATE, SODIUM FORMATE, SODIUM MONOCHLORACETATE AND POTASSIUM  
FORMATE AT 25°.

(Philip and Garner, 1909.)

In $\text{CH}_3\text{COONa.}$		In $\text{HCOONa.}$		In $\text{CH}_2\text{ClCOONa.}$		In $\text{HCOOK.}$	
Gms. per Liter.		Gms. per Liter.		Gms. per Liter.		Gms. per Liter.	
$\frac{\text{CH}_3\text{COONa.}}{\text{C}_6\text{H}_4\text{NO}_2\text{COOH.}}$		$\frac{\text{HCOONa.}}{\text{C}_6\text{H}_4\text{NO}_2\text{COOH.}}$		$\frac{\text{CH}_2\text{ClCOONa.}}{\text{C}_6\text{H}_4\text{NO}_2\text{COOH.}}$		$\frac{\text{HCOOK.}}{\text{C}_6\text{H}_4\text{NO}_2\text{COOH.}}$	
0	3.424	0	3.424	0	3.424	0	3.424
1.009	5.144	0.843	4.776	1.375	4.075	1.025	4.742
2.484	7.032	2.102	6.380	3.426	4.876	2.563	6.446
5.027	12.61	4.196	8.616	6.839	5.861	5.124	8.551
10.07	20.77	8.410	11.90	13.710	7.264		



## SOLUBILITY OF PARA NITRO BENZOIC ACID IN AQUEOUS SOLUTIONS OF ANILIN AND OF PARA TOLUIDIN AT 25°.

(Löwenherz — Z. physik. Chem. 25, 395, '98.)

## In Anilin.

In *p*-Toluidin.

G. Mols. per Liter.		Gms. per Liter.		G. Mols. per Liter.		Gms. per Liter.	
$C_6H_5NH_2$	$C_6H_4(NO_2)COOH$	$C_6H_5NH_2$	$C_6H_4(NO_2)COOH$	$C_6H_4(NO_2)CH_3$	$C_6H_4(NO_2)COOH$	$C_6H_4(NO_2)CH_3$	$C_6H_4(NO_2)COOH$
0.0	0.00164	0.0	0.274	0.0	0.00164	0.0	0.274
0.01	0.00841	0.01	1.406	0.01	0.0100	1.071	1.406
0.02	0.01379	1.82	2.304	0.02	0.0174	2.142	2.304
0.04	0.02172	3.64	3.629	0.03	0.0245	3.213	3.629
0.08	0.0347	7.29	5.798				

1000 cc. of sat. solution of para nitrobenzoic acid in aqueous 1 normal sodium para nitrobenzoate contain 0.0046 gm. mols. = 0.768 gm.  $pC_6H_4(NO_2)COOH$  at 25°.

(Sidgwick)

## SOLUBILITY OF PARA NITROBENZOIC ACID IN SEVERAL ALCOHOLS.

(Timofeiew, 1894.)

Solvent.	t°.	Gms. Acid per 100 Gms. Sat. Sol.		Solvent.	t°.	Gms. Acid per 100 Gms. Sat. Sol.	
$CH_3OH$	18.5	3.45	3.57	$C_2H_5OH$	21	3.22	3.57
"	21	3.75	3.90	$C_3H_7OH$	18.5	2.12	2.36
$C_2H_5OH$	18.5	3.25	3.36	"	19.5	1.85	1.96
"	19.5	3.16	3.26	"	21	2.29	2.36

DinitroBENZOIC ACIDS  $C_6H_3(NO_2)_2COOH$ . 1.3.5 and 1.2.4.

## SOLUBILITY OF 3.5 AND OF 2.4 DINITROBENZOIC ACIDS IN AQUEOUS SOLUTIONS OF SODIUM ACETATE AT 25°.

(Philip and Garner, 1909.)

Gms. per 100 cc. Sat. Sol.		Gms. per 100 cc. Sat. Sol.	
$CH_3COONa$	3.5 $C_6H_3(NO_2)_2COOH$	$CH_3COONa$	2.4 $C_6H_3(NO_2)_2COOH$
0	0.1314	0	0.0572
0.0976	0.3392	0.0976	0.2056
0.2428	0.6720	0.2428	0.3434
0.4846	1.201	0.4846	0.5023
0.9718	2.115	0.9718	0.7440

Data for the solubility of 1.3.5 dinitrobenzoic acid in water and in solutions of KCl, NaCl,  $KNO_3$  and  $NaNO_3$ , and for its distribution between water and benzene at 25°, are given by B. de Szyszkowski (1915).

## SOLUBILITY OF 1.3.5 DINITROBENZOIC ACID IN WATER AT HIGH TEMPERATURE DETERMINED BY THE SYNTHETIC METHOD.

(Flaschner and Rankin, 1910.)

t°.	Gms. Acid per 100 Gms. Sol.	t°.	Gms. Acid per 100 Gms. Sol.	t°.	Gms. A. per 100 Gm. B.
123.8 crit. t.	...	123	66.5	160	90
113	4.4	125	72.7	180	95
120	9.3	130	79.3	200	99
121	14.5	140	85.7	206	100
122	40	150	89		



**SOLUBILITY OF NITROBROMOBENZOIC ACIDS AND OF NITROCHLOROBENZOIC ACIDS IN WATER AT 25°.**

(Holleman, 1910.)

Acid.	Gms. Acid per 100 cc. Sol.	Acid.	Gms. Acid per 100 cc. Sol.
$\text{C}_6\text{H}_4(\text{COOH})\text{NO}_2\text{Br}$ 1.2.3	0.033	$\text{C}_6\text{H}_3(\text{COOH})\text{NO}_2\text{Cl}$ 1.2.3	0.047
$\text{C}_6\text{H}_3(\text{COOH})\text{NO}_2\text{Br}$ 1.2.5	0.741	$\text{C}_6\text{H}_3(\text{COOH})\text{NO}_2\text{Cl}$ 1.2.5	0.967

Holleman also gives data for the solubility of various mixtures of the above two bromo compounds and of the two chloro compounds and uses the results for estimating the quantity of each in an unknown mixture.

**Dinitro *p* oxyBENZOIC ACID**  $\text{C}_6\text{H}_3\text{OH}(\text{NO}_2)_2\text{COOH}$ .

**SOLUBILITY OF MIXTURES OF DINITRO PARA OXYBENZOIC ACID AND OTHER COMPOUNDS IN ABSOLUTE ETHYL ALCOHOL AT 29.6°.**

(Morgenstern, 1911.)

Dinitro <i>p</i> Oxybenzoic Acid + Phenanthrene.			Dinitro <i>p</i> Oxybenzoic Acid + Fluorene.			Dinitro <i>p</i> Oxybenzoic Acid + Retene.		
Gms. per 100 gms. Sat. Sol.		Solid Phase.	Gms. per 100 gms. Sat. Sol.		Solid Phase.	Gms. per 100 gms. Sat. Sol.		Solid Phase.
Acid.	Phenanthrene.		Acid.	Fluorene.		Acid.	Retene.	
2.0483	0.1333	Acid	2.0440	0.1232	Acid	2.0232	0	Acid
2.0776	0.2796	"	2.0823	0.3484	"	2.0484	0.1236	"
2.1249	0.5267	"	2.1045	0.4824	"	2.0933	0.3446	"
2.2195	1.0311	"	2.1744	0.8960	"	2.1276	0.5162	"
2.2883	1.4310	"	2.2618	1.4308	"	2.2346	1.0489	"
1.2171	6.0092	Phenanthrene	1.0490	3.8618	Fluorene	2.3034	1.3634	"
0.8681	5.8300	"	0.8004	3.7566	"	1.9664	3.3698	Retene
0.6017	5.6890	"	0.5620	3.6532	"	0.7830	3.0032	"
0.3487	5.5619	"	0.3900	3.5811	"	0.5597	2.9331	"
0.2157	5.4890	"	0.2113	3.5024	"	0.2740	2.8466	"
0	5.3781	"	0	3.4115	"	0	2.2795	"

**BENZOIC ANHYDRIDE**  $(\text{C}_6\text{H}_5\text{CO})_2\text{O}$ .

Freezing-point data are given for mixtures of benzoic anhydride and sulfuric acid by Kendall and Carpenter (1914).

**BENZOIN** (Benzoyl phenyl carbinol)  $\text{C}_6\text{H}_5\text{CH}(\text{OH})\text{COC}_6\text{H}_5$ .

**SOLUBILITY OF BENZOIN IN WATER, PYRIDINE AND AQUEOUS 50% PYRIDINE AT 20-25°.**

(Dehn, 1917.)

Solvent.]	Gms. Benzoïn per 100 gms. Solvent.
Water	0.03
Aq. 50 % Pyridine	6.63
Pyridine	20.20

100 gms. 95% formic acid dissolve 3.06 gms. benzoïn at 18.5°. (Aschan, 1913.)

Freezing-point data (solubilities, see footnote, p. 1) are given by Vanstone (1913), for mixture of benzoïn and each of the following compounds:

Dibenzyl, benzylaniline, benzylideneaniline and hydrazobenzene.



**BENZOPHENONE** ( $\text{C}_6\text{H}_5$ )<sub>2</sub>CO.**SOLUBILITY IN AQUEOUS ALCOHOL AND IN OTHER SOLVENTS.**

(Derrien — Compt. rend. 130, 722, '00; Bell — J. Physic. Chem. 9, 550, '05.)

**In Aqueous Alcohol at 40°.**

(Bell.)

Wt. % Alcohol in Solvent.	Gms. ( $\text{C}_6\text{H}_5$ ) <sub>2</sub> CO per 100 Gms. Solvent.    Solution.		Wt. % Alcohol in Solvent.	Gms. ( $\text{C}_6\text{H}_5$ ) <sub>2</sub> CO per 100 Gms. Solvent.    Solution.	
40	2	1.9	67.5	39	28.1
45	5	4.8	70	56	35.9
50	8	8.3	71	67	39.2
55	11	9.9	72	90	47.4
60	16	13.8	72.5	105	51.2
65	28	22.6	73	156	61.0

**In Aqueous Alcohol and other Solvents.**

(Derrien.)

Solvent.	t°.	Gms. ( $\text{C}_6\text{H}_5$ ) <sub>2</sub> CO per 100 cc. Solvent.	Solvent.	t°.	Gms. ( $\text{C}_6\text{H}_5$ ) <sub>2</sub> CO per 100 cc. Solvent.
97% Ethyl Alcohol	17	13.5	Ethyl Ether (rectified)	12.7	17.5
85 cc. 97% Alcohol + 15 cc. H <sub>2</sub> O	17	3.8	Benzene	17	76.9
80 " " + 20 "	17	2.2	Xylene	17.6	38.4
75 " " + 26 "	17	1.3	Nitro Benzene	15.8	58.8
Methyl Alcohol (pure)	9.8	11	Chloroform (com.)	16.5	55.5
" " "	15	14.3	Bromoform	17.3	33.3
Acetic Ether (pure)	9.6	19.2	Toluene	17.2	55.5
Carbon Disulfide	16.1	66.6	Ligroïne	14.6	6.7

Determinations made by means of the Pulfrich refractometer (Osaka, 1903-8), gave 39 gms. benzophenone per 100 gms. absolute ethyl alcohol at 20°, and 78.6 gms. benzophenone per 100 gms. benzene at 25°.

**SOLUBILITY OF BENZOPHENONE IN AQUEOUS SOLUTIONS OF PHENOL AND OF n BUTYRIC ACID, DETERMINED BY THE SYNTHETIC METHOD, ARE GIVEN BY TIMMERMANS (1907).**

In Aq. 36.51% $\text{C}_6\text{H}_5\text{OH}$ (Sat. t = 65.3).		In Aq. 71.4% $\text{C}_6\text{H}_5\text{OH}$ (Sat. t = 20.6).		In Aq. 39.4% $\text{C}_6\text{H}_7\text{COOH}$ (Sat. t = -2.3).	
t° of Sat.	Gms. ( $\text{C}_6\text{H}_5$ ) <sub>2</sub> CO per 100 Gms. Sat. Sol.	t° of Sat.	Gms. ( $\text{C}_6\text{H}_5$ ) <sub>2</sub> CO per 100 Gms. Sat. Sol.	t° of Sat.	Gms. ( $\text{C}_6\text{H}_5$ ) <sub>2</sub> CO per 100 Gms. Sat. Sol.
75.4	0.685	26.1	0.96	6.1	0.439
81.1	1.06	29.3	1.77	18.5	1.12
85.3	1.41	39.5	4.06	28.9	1.71
88.1	1.67	55.5	7.82	44	2.66
		82.6	16.82	61.6	3.92
				75.2	5.09

Solubility data for mixtures of benzophenone and resorcinol and for benzophenone and pyrocatechinol, determined by the freezing-point method, are given by Freundlich and Posnjak (1912). Similar data for mixtures of benzophenone and thymol are given by Pawlewski (1893). Results for mixtures of benzophenone and sulfuric acid are given by Kendall and Carpenter (1914).

**BENZOYL CHLORIDE, BENZOYL** tetra hydro quinaldine, *d* and *l*.

Fusion-point data are given for mixtures of benzoyl chloride and phenol by Tsakalotos and Guye (1910), and for mixtures of the *d* and *l* forms of benzoyl tetrahydroquinaldine, by Adriani (1900).



**BENZYLAMINE HYDROCHLORIDE**  $C_6H_5CH_2.NH_2.HCl$ .100 gms.  $H_2O$  dissolve 50.6 gms. of the compound at  $25^\circ$ . (Peddle and Turner, 1913.)**DIBENZYLAMINE HYDROCHLORIDE**  $(C_6H_5CH_2)_2NH.HCl$ .100 gms.  $H_2O$  dissolve 2.17 gms. of the compound at  $25^\circ$ . (Peddle and Turner, 1913.)100 gms. chloroform dissolve 0.37 gm. of the compound at  $25^\circ$ . "**TRIBENZYLAMINE HYDROCHLORIDE**  $(C_6H_5CH_2)_3N.HCl$ .100 gms.  $H_2O$  dissolve 0.61 gm. of the compound at  $25^\circ$ . (Peddle and Turner, 1913.)100 gms. chloroform dissolve 11.41 gms. of the compound at  $25^\circ$ . "**DIBENZYL**  $C_6H_5CH_2.C_6H_5CH_2$ , **BENZYLANILINE**  $C_6H_5CH_2.NHC_6H_5$ .

SOLUBILITY DATA, DETERMINED BY THE FREEZING-POINT METHOD (see footnote, p. 1), ARE GIVEN FOR THE FOLLOWING MIXTURES:

Dibenzyl + Stilbene	(Bruni, 1898; Pascal and Normand, 1903.)
" + Benzylphenol	(Pascal and Normand, 1913.)
" + Hydrobenzene	" "
" + Tolane	" "
Benzylaniline + Dibenzyl	" "
" + Stilbene	" "
" + Benzylphenol	" "
" + Hydrazobenzene	" "
" + Tolane	" "

**NITROBENZYL CHLORIDE**  $p$   $C_6H_5CHNO_2.Cl$ .SOLUBILITY IN SEVERAL SOLVENTS AT  $25^\circ$ . (v. Halban, 1913.)

Solvent.	Gms. $p$ $C_6H_5CHNO_2.Cl$ per 100 Gms.		Solvent.	Gms. $p$ $C_6H_5CHNO_2.Cl$ per 100 Gms.	
	Solvent.	Sat. Sol.		Solvent.	Sat. Sol.
Methyl Alcohol	8.87	8.15	Nitrobenzene	57.8	36.4
Ethyl Alcohol	7.10	6.63	Ethylacetate	57.8	36.4
Propyl Alcohol	5.70	5.39	Ethylbenzoate	43.3	30.2
Amyl Alcohol	4.88	4.65	Ethylnitrite	51.2	33.9
Butyl Alcohol	21.5	17.7	Isoamylbromide	12.5	10.4
Acetic Acid	18.1	15.3	Brombenzene	32	24.2
Acetone	107	51.7	Chloroform	47.6	32.3
Acetophenone	63.1	38.7	Carbon Tetrachloride	6.05	5.69
Paraldehyde	24.9	19.9	Benzylchloride	45.3	31.2
Ether	23.1	18.8	$\alpha$ Bromnaphthaline	31.7	23.4
Acetonitrile	96.6	49.1	$n$ Hexane	1.30	1.28
Nitromethane	68.8	40.8	Isopentane	0.49	0.49
$\sigma$ Nitrotoluene	51.1	33.8	Benzene	69.7	37.4

Data for the lowering of freezing-point are given by Holleman (1914) for mixtures of  $\sigma$  and  $p$  nitro benzylchloride.**DIBENZYL HYDRAZINE**  $C_6H_5CH_2.NH.C_6H_5CH_2.NH$ .

Reciprocal solubilities of dibenzylhydrazine and cinnamylidene, determined by the method of lowering of the fr.-pt. (see footnote, p. 1), are given by Pascal ('14).

**ChloronitroBENZYLIDENES**  $C_6H_5C:NO_2.Cl$ . **BENZYLIDENE NAPHTHALAMINES**  $C_6H_5CH:NC_{10}H_7$ .

DATA FOR THE LOWERING OF THE FREEZING-POINTS (solubilities, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES.

$\sigma$ Chloronitrobenzylidene + $m$ Chloronitrobenzylidene	(Holleman, 1914.)
$p$ " + $m$ "	" "
$p$ " + $\sigma$ "	" "
$\alpha$ Benzylidene naphthalamine + $\beta$ Benzylidene naphthalamine	(Pascal and Normand, '13.)

**BERYLLIUM ACETATE** (basic)  $Be_4O(CH_3COO)_6$ .100 gms. chloroform dissolve 33.3 gms.  $Be_4O(CH_3COO)_6$  at  $18^\circ$ . (Wirth, 1914.)



# **BERYLLIUM FLUORIDE**

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## **BERYLLIUM** Potassium **FLUORIDE**, etc.

SOLUBILITY IN WATER AND IN ACETIC ACID SOLUTIONS.  
(Marignac; Sestini, 1890.)

Salt.	Formula.	Solvent.	Gms. Anhyds per 100 Gms. At 20°.
Beryllium potassium fluoride	$\text{BeF}_2 \cdot \text{KF}$	Water	2.0
" sodium "	$\text{BeF}_2 \cdot \text{NaF}$	"	1.4
" hydroxide	$\text{Be}(\text{OH})_2$	Water + $\text{CO}_2$ sat.	0.0185 (Be
" phosphate	$\text{Be}_3(\text{PO}_4)_2 \cdot 6\text{H}_2\text{O}$	2% $\text{CH}_3\text{COOH}$	0.055
" "	"	10% "	0.1725

## **BERYLLIUM HYDROXIDE** $\text{Be}(\text{OH})_2$ .

SOLUBILITY IN AQUEOUS SOLUTIONS OF SODIUM HYDROXI  
(Rubenbauer — Z. anorg. Chem. 30 334, '02.)

Moist  $\text{Be}(\text{OH})_2$  used, solutions shaken 5 hours, temperatur  
abiy about 20°.

Per 20 cc. Solution.		Molecular Dilution of the NaOH.	Gms. per 100 cc. Solution.	
Gms. Na.	Gms. Be.		NaOH.	$\text{Be}(\text{OH})_2$ .
0.3358	0.0358	1.37	2.917	0.850
0.6716	0.0882	0.68	5.840	2.094
0.8725	0.1175	0.53	7.585	2.789
1.7346	0.2847	0.27	18.310	6.760

SOLUBILITY IN AQUEOUS SODIUM HYDROXIDE AT DIFFERENT TEMPER  
(Habcr and Oordt, 1904.)

Normality of Aq. NaOH.	Gm. BeO per Liter Sat. Sol. at:		
	20-23°.	50-53°.	100°.
0.5	0.060	0.080	0.080
1	0.170	0.230	0.290
2	0.570	0.900	1.020

## **BERYLLIUM OXALATE** $\text{BeC}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$ .

100 gms.	water	dissolve 63.2 gms. $\text{BeC}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$ at 25° (Wi
"	0.1 % oxalic acid	" 75.92 "
"	0.1 % sulfuric	" 72.65 "
"	1.0 % "	" 52.8 "

## **BERYLLIUM PALMITATE** and Salts of Other Fatty Acids.

SOLUBILITIES IN ETHYL AND METHYL ALCOHOLS AT 25°. (Jacobson and Holm

Solvent.	Gms. of Each Salt (Determined Separately) per 100 Gms. S			
	Be Palmitate.	Be Stearate.	Be Laurate.	Be M
Ethyl Alcohol	0.004	...	0.004	0.
Methyl Alcohol	0.042	0.040	0.050	0.

## **BERYLLIUM SULFATE** $\text{BeSO}_4 \cdot 6\text{H}_2\text{O}$ .

SOLUBILITY IN WATER. (Levi, Malvano, 1906.)

t°.	Mols. $\text{H}_2\text{O}$ per 1 Mol. $\text{BeSO}_4$ .	Gms. $\text{BeSO}_4$ per 100 Gms.		Solid Phase.	t°.	Mols. $\text{H}_2\text{O}$ per 1 Mol. $\text{BeSO}_4$ .	Gms. $\text{BeSO}_4$ per 100 Gms.		
		Water.	Solution.				Water.	Solution.	
31	11.18	52.23	34.32	$\text{BeSO}_4 \cdot 6\text{H}_2\text{O}$	95.4	6.44	90.63	47.55	Be
50	9.62	60.67	37.77	"	107.2	5.06	115.3	53.58	
72.2	7.79	74.94	42.85	"	111	4.55	124.3	56.19	
77.4	7.13	81.87	45.01	"	80	6.89	84.76	45.87	Be
30	13.33	43.78	30.45	$\text{BeSO}_4 \cdot 4\text{H}_2\text{O}$	91.4	5.97	97.77	49.42	
40	12.49	46.74	31.85	"	105	4.93	118.4	54.21	
68	9.42	61.95	38.27	"	119	3.91	149.3	59.88	
85	7.65	76.30	43.28	"					



## SOLUBILITY OF BERYLLIUM SULFATE IN AQUEOUS SULFURIC ACID AT 25°.

(Wirth, 1912-13.)

Gms. H <sub>2</sub> SO <sub>4</sub> per 100 Gms. Solvent.	Gms. BeSO <sub>4</sub> per 100 Gms. Sat. Sol.	Solid Phase.	Gms. H <sub>2</sub> SO <sub>4</sub> per 100 Gms. Solvent.	Gms. BeSO <sub>4</sub> per 100 Gms. Sat. Sol.	Solid Phase.
0	8.212	BeSO <sub>4</sub> ·6H <sub>2</sub> O	45.51	6.628	BeSO <sub>4</sub> ·6H <sub>2</sub> O
5.23	8.429	"	50.63	5.438	BeSO <sub>4</sub> ·4H <sub>2</sub> O
9.61	7.944	"	56.59	3.640	"
18.70	6.603	"	63.24	2.244	"
34	5.631	"	65.24	2.128	"
40.35	5.773	"	73.64	2.185	"

Freezing-point data for mixtures of beryllium sulfate and potassium sulfate are given by Graumann (1913).

BERYLLIUM MetaVANADATE Be(VO<sub>3</sub>)<sub>2</sub>·4H<sub>2</sub>O.100 gms. H<sub>2</sub>O dissolve 0.1 gm. of the salt at 25°.

(Brinton, 1916.)

BETAINE (Trimethyl glycocoll) C<sub>5</sub>H<sub>11</sub>O<sub>2</sub>N·H<sub>2</sub>O.

## SOLUBILITY OF ANHYDROUS BETAINE IN WATER AND ALCOHOLS.

(Stoltzenberg, 1914.)

(Figures read from the author's curves.)

t°.	F Gms. C <sub>5</sub> H <sub>11</sub> O <sub>2</sub> N per 100 Gms.			t°.	Gms. C <sub>5</sub> H <sub>11</sub> O <sub>2</sub> N per 100 Gms.		
	H <sub>2</sub> O.	CH <sub>3</sub> OH.	C <sub>2</sub> H <sub>5</sub> OH.		H <sub>2</sub> O.	CH <sub>3</sub> OH.	C <sub>2</sub> H <sub>5</sub> OH.
-10	134	38	5	50	197	70	16
0	140	43	6	60	215	75	18.5
+10	147	49	7	70	236	80	22
20	157	54	8.5	80	259	..	25
30	168	60	11	90	286	..	...
40	182	65	13	100	328	..	...

## BETAINE SALTS.

## SOLUBILITY OF EACH, SEPARATELY, IN WATER.

(Stoltzenberg, 1914.)

Grams per 100 Grams H<sub>2</sub>O.

t°.	C <sub>5</sub> H <sub>11</sub> O <sub>2</sub> N. HCl.	C <sub>5</sub> H <sub>11</sub> O <sub>2</sub> N. HBr.	C <sub>5</sub> H <sub>11</sub> O <sub>2</sub> N. HI.	C <sub>5</sub> H <sub>11</sub> O <sub>2</sub> N. H <sub>2</sub> SO <sub>4</sub> ·H <sub>2</sub> O.	C <sub>5</sub> H <sub>11</sub> O <sub>2</sub> N. H <sub>3</sub> PO <sub>4</sub> .	C <sub>5</sub> H <sub>11</sub> O <sub>2</sub> N. HMnO <sub>4</sub> .	C <sub>5</sub> H <sub>11</sub> O <sub>2</sub> N. HAuCl <sub>4</sub> .
-10	38	28	35	67	35	1.5	1.3
0	44	39	66	86	45	1.75	1.5
+10	52	52	98	107	58	2.5	2
20	60	65	130	132	73	5	3
30	70	79	162	164	91	9	4.5
40	81	94	198	203	112	16	6
50	93	110	231	250	135	30	8
60	106	127	269	306	160	(55°) 48	11.5
70	120	144	304	...	190	...	15
80	135	162	(75°) 321	...	223	...	18
90	151	183	...	...	...	...	23
100	169	206	...	...	...	...	...

Data are also given by Stoltzenberg for the following basic salts of betaine (C<sub>5</sub>H<sub>11</sub>O<sub>2</sub>N)<sub>2</sub>HCl·H<sub>2</sub>O, (C<sub>5</sub>H<sub>11</sub>O<sub>2</sub>N)<sub>2</sub>HBr, (C<sub>5</sub>H<sub>11</sub>O<sub>2</sub>N)<sub>2</sub>HI, (C<sub>5</sub>H<sub>11</sub>O<sub>2</sub>N)<sub>2</sub>H<sub>2</sub>SO<sub>4</sub> and (C<sub>5</sub>H<sub>11</sub>O<sub>2</sub>N)<sub>2</sub>HAuCl<sub>4</sub>·H<sub>2</sub>O.

BETOL (β-Naphthylsalicylate) βC<sub>7</sub>H<sub>5</sub>O<sub>2</sub>·C<sub>10</sub>H<sub>7</sub>.

Freezing-point data including super solubility curves, are given for mixtures of betol and salol by Miers and Isaac, 1907.



**BISMUTH Bi.**

RECIPROCAL SOLUBILITIES, DETERMINED BY THE METHOD OF LOW FUSION-POINT (see footnote, p. 1), ARE GIVEN FOR THE FOLLOWING MIXTURES:

Bismuth + Bromine	(Eggink, 1908.)
" + Chlorine	"
" + Iodine	(Amadori and Becarelli, 1912.)
" + Sulfur	(Aten, 1905; Palabon, 1904.)

**MUTUAL SOLUBILITY OF BISMUTH AND ZINC.** (Spring and Romanoff,

t°.	Upper Layer.		Lower Layer.		t°.	Upper Layer.		Lower Layer.
	%Bi.	%Zn.	%Bi.	%Zn.		%Bi.	%Zn.	
266	86	14	..	..	584	80	20	10
419	..	..	3	97	650	77	23	15
475	84	16	5	95	750	70	30	27
					810-820 (crit. temp.)			

**BISMUTH CHLORIDE.  $\text{BiCl}_3$ . BISMUTH OXYCHLORIDE  $\text{BiOCl}$** 

SOLUBILITY IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID

Results at 25°. (Noyes and Hall, 1917.)

Results at 30°. (Jacobsen, 1905.)

d <sub>4</sub> <sup>20</sup> of Sat. Sol.	Gms. Atoms per 1000 Gms. H <sub>2</sub> O.			Gms. per 100 Gms. Sat. Solution.		S
	Cl.	Bi.	H(=Cl-3Bi).	BiO <sub>2</sub> .	HCl.	
1.002	0.3477	0.00130	0.3438	0.60	2.40	F
1.007	0.4350	0.00376	0.4237	5.35	5.69	
1.010	0.5221	0.00869	0.4960	8.17	8.47	
1.013	0.6244	0.01767	0.5714	8.70	8.93	
1.018	0.7375	0.03138	0.6434	14.52	13.02	
1.025	0.8824	0.05338	0.7223	18.60	15.80	
1.036	1.0760	0.08937	0.8079	30.10	21.7	
1.044	1.2277	0.1177	0.8746	36.95	25.4	
1.061	1.5321	0.1810	0.9891	54.70	31.5	
1.083	1.9021	0.2657	1.105	56	32.8	
1.157	3.1865	0.5685	1.481	58.5	33	I
1.237	4.5056	0.9022	1.799	56.6	33.8	
1.288	5.325	1.100	2.025	56.25	34.9	
1.329	6.066	1.317	2.115	55.9	35.9	J

**SOLUBILITY OF BISMUTH CHLORIDE IN SEVERAL SOLVENTS.**

Solvent.	t°.	Gms. $\text{BiCl}_3$ per 100.		At
		cc. Solvent.	Gms. Solvent.	
Acetone	18°	...	17.9 ( $d_{15}=0.9194$ )	(Naumai)
Ethyl Acetate	18°	...	1.66 ( $d_{15}=0.9106$ )	(Naumai)
Anhydrous Hydrazine ord. temp.	32	...	...	(Welsh and Brod)
100 gms. 95% formic acid dissolve 0.05 gm. bismuth oxychloride (1908°).				

Freezing-point data are given for  $\text{BiCl}_3+\text{CuCl}$ ,  $\text{BiCl}_3+\text{FeCl}_3$ ,  $\text{BiCl}_3+\text{PbBr}_2$  and  $\text{BiCl}_3+\text{ZnCl}_2$  by Herrmann (1911) and for  $\text{BiCl}_3$  Scarpa (1912).

**BISMUTH CITRATE  $(\text{CH}_3)_2\text{C}(\text{OH})(\text{COO})_2\text{Bi}$ .****BISMUTH A**

SOLUBILITY OF EACH IN WATER AND IN AQUEOUS ETHYL ALCOHOL AT 25°.

Gms. $\text{C}_2\text{H}_5\text{OH}$ per 100 Gms. Solvent.	Gms. $\text{C}_2\text{H}_5\text{O}_2\text{Bi}$ per 100 Gms. Sat. Sol.	Gms. $\text{C}_2\text{H}_5\text{OH}$ per 100 Gms. Solvent.	Gms. $\text{Bi.NH}_4$ Citrate per 100 Gms. Sat. Sol.	d <sub>4</sub>
0	0.011	0	22.25	
51	0.041	51	1.34	
91.4	0.065	91.4	None	



**BISMUTH HYDROXIDE**  $\text{Bi}(\text{OH})_3$ .

SOLUBILITY OF BISMUTH HYDROXIDE IN AQUEOUS SOLUTIONS OF SODIUM AND POTASSIUM HYDROXIDES AT 20° AND AT 100°.

(Moser, 1909.)

Gms. KOH per Liter.	Gms. Dissolved $\text{Bi}(\text{OH})_3$ per Liter at:		Gms. NaOH per Liter.	Gms. Dissolved $\text{Bi}(\text{OH})_3$ per Liter at:	
	20°.	100°.		20°.	100°.
28	0	0.188	20	0	0.188
50	trace	0.249	40	trace (0.0014)*	0.249
112	0.037	0.373	80	0.050 (0.0029)*	0.436
168	0.074	...	120	0.087 (0.0054)*	0.622
224	0.100	0.622	160	0.100	...
280	0.124	0.622	200	0.124	0.622
336	0.137	...	240	0.137	...
448	0.137	1.494	320	0.137	1.494
560	0.174	2.054	400	0.199	2.120

\* Results at 25° by Knox (1909).

At 100° some  $\text{Bi}(\text{OH})_3$  was converted into  $\text{BiO}(\text{OH})$ . †

SOLUBILITY OF BISMUTH HYDROXIDE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE AND OF POTASSIUM BROMIDE AT 30°.

(Herz and Bulla, 1909.)

(An excess of bismuth hydroxide, prepared according to Moses and having the composition corresponding to  $\text{BiO} \cdot \text{OH}$ , was shaken 2-3 weeks at 30° with aqueous KCl and KBr. The analyses of the sat. solutions are expressed in terms of millimoles KOH and KCl or KBr. They have been calculated for the following table to gms.  $\text{BiO} \cdot \text{OH}$  and KCl or KBr.)

Solvent.	Gms. per 100 cc. Sat. Sol.		Solvent.	Gms. per 100 cc. Sat. Sol.	
	$\text{BiO} \cdot \text{OH}$ .	KCl.		$\text{BiO} \cdot \text{OH}$ .	KBr.
2 N KCl	3.759	13.75	1 N KBr	8.555	7.67
3 N KCl	5.745	20.71	2 N KBr	17.785	15.02

**BISMUTH IODIDE**  $\text{BiI}_3$ .

100 gms. absolute alcohol dissolve 3.5 gms.  $\text{BiI}_3$  at 20°. (Gott and Muir, 1888)

100 gms. methylene iodide,  $\text{CH}_2\text{I}_2$ , dissolve 0.15 gm.  $\text{BiI}_3$  at 12°. (Retgers, 1893)

**BISMUTH NITRATE**  $\text{Bi}(\text{NO}_3)_3 \cdot 5\text{H}_2\text{O}$ .

100 gms. acetone dissolve 48.66 gms.  $\text{Bi}(\text{NO}_3)_3 \cdot 5\text{H}_2\text{O}$  at 0°, and 41.7 gms. at 19°. (von Laszczynski, 1894.)

SOLUBILITY OF BISMUTH NITRATE IN AQUEOUS NITRIC ACID AND IN AQUEOUS NITRIC ACID CONTAINING ACETONE, AT ORDINARY TEMPERATURE.

(Dubrissay, 1911.)

Solvent.	Gms. $\text{Bi}(\text{NO}_3)_3$ per per 100 cc. sat. Sol.	Solid Phase.
0.922 N $\text{HNO}_3$	86.86	$\text{Bi}(\text{NO}_3)_3 \cdot 5\text{H}_2\text{O}$
0.922 " " + 6.66% Acetone	85.51	"
0.922 " " + 13.33% " "	81.96	"
2.3 " " "	80.37	"
2.3 " " + 16.66% " "	74.47	"

SOLUBILITY OF DOUBLE NITRATES OF BISMUTH AND MAGNESIUM, NICKEL, COBALT, ZINC AND MANGANESE IN CONC.  $\text{HNO}_3$  AT 16°.

(Jantsch, 1912.)

( $d_4$  of  $\text{HNO}_3 = 1.325$ , 100 cc. of this acid contained 51.59 gms.  $\text{HNO}_3$ .)

Double Salt.	Gms. Hydrated Salt per 100 cc. Sat. Solution.	Double Salt.	Gms. Hydrated Salt per 100 cc. Sat. Solution.
$\text{Bi}_2\text{Mg}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$	41.69	$\text{Bi}_2\text{Zn}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$	57.51
$\text{Bi}_2\text{Ni}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$	46.20	$\text{Bi}_2\text{Mn}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$	65.77
$\text{Bi}_2\text{Co}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$	54.67		



BISMUTH OXIDE  $\text{Bi}_2\text{O}_3$ .

SOLUBILITY OF BISMUTH OXIDE IN AQUEOUS NITRIC ACID AT 20°.  
(Rutten and van Bemmelen, 1902.)

Present in Shaker Flask. per 1 part $\text{Bi}_2\text{O}_3$ . $3\text{N}_2\text{O}_5 \cdot 10\text{H}_2\text{O}$ .	Gms. per 100 Gms. Solution.		Mols. per 100 Mols. $\text{H}_2\text{O}$ .			Solid Phase.
	$\text{Bi}_2\text{O}_3$	$\text{N}_2\text{O}_5$	$\text{Bi}_2\text{O}_3$	$\text{N}_2\text{O}_5$	Ratio $\text{Bi}_2\text{O}_3$ : $\text{N}_2\text{O}_5$ .	
1.4 parts $\text{H}_2\text{O}$	0.321	0.063	0.126	1.61	1:12.8	$\text{Bi}_2\text{O}_3 \cdot \text{N}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$
1.2 parts $\text{H}_2\text{O}$	6.37	7.17	2.844	13.82	1: 4.8	
dilute $\text{HNO}_3$	18.74	15.9	10.50	38.65	1: 3.6	$\text{Bi}_2\text{O}_3 \cdot \text{N}_2\text{O}_5 \cdot \text{H}_2\text{O}$
dilute $\text{HNO}_3$	31.48	23.7	27.2	83.8	1: 3.0	
dilute $\text{HNO}_3$ = 6.13% $\text{N}_2\text{O}_5$	32.93	24.83	30.15	97.97	1: 3.2	$\text{Bi}_2\text{O}_3 \cdot \text{N}_2\text{O}_5 \cdot \text{H}_2\text{O}$ and $\text{Bi}_2\text{O}_3 \cdot 3\text{N}_2\text{O}_5 \cdot 10\text{H}_2\text{O}$
6.816% $\text{N}_2\text{O}_5$	32.67	24.70	29.70	96.57	1: 3.2	
24.0% $\text{N}_2\text{O}_5$	24.16	28.25	19.65	98.76	1: 5.0	$\text{Bi}_2\text{O}_3 \cdot 3\text{N}_2\text{O}_5 \cdot 10\text{H}_2\text{O}$
51.0% $\text{N}_2\text{O}_5$	11.66	46.62	10.81	186.23	1:17.2	
70.0% $\text{N}_2\text{O}_5$	20.76	53.75	33.51	355.87	1:10.6	$\text{Bi}_2\text{O}_3 \cdot 3\text{N}_2\text{O}_5 \cdot 10\text{H}_2\text{O}$ and $\text{Bi}_2\text{O}_3 \cdot 3\text{N}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$
	27.85	51.02	51.0	403.0	1: 7.9	
anhydrous $\text{HNO}_3$	8.56	68.28	14.35	492.0	1:34.3	$\text{Bi}_2\text{O}_3 \cdot 3\text{N}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$
$\text{H}_2\text{O}$ + "	4.05	74.90	7.45	592.9	1:79.5	

Results are also given for 9°, 30°, and 65°.

BISMUTH TRIPHENYL  $\text{Bi}(\text{C}_6\text{H}_5)_3$ .

Fusion-point data (see footnote, p. 1) are given for mixtures of bismuth triphenyl and mercury diphenyl by Cambi (1912).

BISMUTH SALICYLATE (basic, 64%  $\text{Bi}_2\text{O}_3$ ).

SOLUBILITY IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°.  
(Seidell, 1910.)

Gms. $\text{C}_2\text{H}_5\text{OH}$ per 100 Gms. Solvent.	Gms. Salt per 100 Gms. Sat. Sol.	Gms. $\text{C}_2\text{H}_5\text{OH}$ per 100 Gms. Solvent.	Gms. Salt per 100 Gms. Sat. Sol.
0	0.010	80	0.065
20	0.015	90	0.095
40	0.022	92.3	0.105
60	0.036	100	0.160

BISMUTH SELENIDE  $\text{Bi}_2\text{Se}_3$ .

Fusion-point data (see footnote, p. 1) are given for mixtures of bismuth selenide and silver selenide by Pelabon (1908).

BISMUTH SULFIDE  $\text{Bi}_2\text{S}_3$ .

1 liter  $\text{H}_2\text{O}$  dissolves 0.00018 gm.  $\text{Bi}_2\text{S}_3$  at 18°.

(Weigel, 1906; see also Bruner and Zawadzki, 1912.)

SOLUBILITY OF BISMUTH SULFIDE IN AQUEOUS ALKALI SULFIDE SOLUTIONS AT 25°.  
(Knox, 1909.)

Solvent.	Gms. $\text{Bi}_2\text{S}_3$ per 100 cc. Sat. Solution.	Solvent.	Gms. $\text{Bi}_2\text{S}_3$ per 100 cc. Sat. Solution.
0.5 <i>N</i> $\text{Na}_2\text{S}$	0.0040	0.5 <i>N</i> $\text{Na}_2\text{S} + 1 N \text{NaOH}$	0.0185
1.0 " "	0.0238	1 <i>N</i> $\text{Na}_2\text{S} + 1 N \text{NaOH}$	0.0838
1.5 " "	0.1023	0.5 <i>N</i> $\text{K}_2\text{S} + 1 N \text{KOH}$	0.0240
0.5 <i>N</i> $\text{K}_2\text{S}$	0.0043	1 <i>N</i> $\text{K}_2\text{S} + 1 N \text{KOH}$	0.1230
1 " "	0.0337	1.25 <i>N</i> $\text{K}_2\text{S} + 1.25 N \text{KOH}$	0.2354
1.5 " "	0.0639		

Freezing-point data (see footnote, p. 1) are given for mixtures of bismuth sulfide and bismuth telluride by Amadori (1915).

ORAX, see sodium tetraborate, p. 629.



BORIC ACID  $\text{H}_3\text{BO}_3$ .

## SOLUBILITY OF BORIC ACID IN WATER.

(Nasini and Ageno, 1909.)

t°.	Gms. $\text{H}_3\text{BO}_3$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{H}_3\text{BO}_3$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{H}_3\text{BO}_3$ per 100 Gms. Sat. Sol.
-0.76 Eutec	2.27	30	6.30	80	19.11
0	2.59	40	8.02	90	23.30
-10	3.45	50	10.35	100	28.7
20	4.8	60	12.90	110	38.7
25	5.5	70	15.70	120	52.4

The results of Herz and Knoch (1904), and one determination by Auerbach (1903), given in terms of gms. per 100 cc. sat. solution, appear to be in good agreement with the above. The earlier data of Ditte (1877) are low.

## SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF HYDROCHLORIC, SULPHURIC, AND NITRIC ACIDS AT 26°.

(Herz — Z. anorg. Chem. 33, 355, 34, 205, '03.)

Normality of H <sub>2</sub> SO <sub>4</sub> , HCl or HNO <sub>3</sub> .	Normality of Dissolved B(OH) <sub>3</sub> .	Gms. Strong Acid per 100 cc. Solution.	Gms. B(OH) <sub>3</sub> per 100 cc. Solution.		
			In HCl.	In H <sub>2</sub> SO <sub>4</sub> .	In HNO <sub>3</sub> .
0	0.91	0	5.64	5.64	5.64
0.5	0.78	5	4.0	4.25	4.50
1.0	0.71	10	3.2	3.6	3.9
2.0	0.58	15	2.45	3.0	3.35
3.0	0.49	20	1.8	2.5	2.9
4.0	0.41	25	...	2.0	2.55
5.0	0.35	30	...	1.55	2.1
6.0	0.26	35	...	...	1.75

The determinations given in the original tables in terms of normal solutions when plotted together lay close to an average curve drawn through them. The figures in the tables here shown were read (and calculated) from the average curve.

## SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF ELECTROLYTES AT 25°.

(Bogdan — Ann. Scient. Univ. Jassy, 2, 47, '02-'03.)

Gms. Electro- lyte per 100 Gms. H <sub>2</sub> O.	Grams $\text{H}_3\text{BO}_3$ per 100 Gms. H <sub>2</sub> O in Aq. Solutions of:					
	NaCl.	KCl.	NaNO <sub>3</sub> .	KNO <sub>3</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	K <sub>2</sub> SO <sub>4</sub> .
0	5.75	5.75	5.75	5.75	5.75	5.75
10	5.75	5.80	5.78	5.81	5.88	5.92
20	5.74	5.86	5.81	5.88	6.00	6.10
40	5.72	5.98	5.87	6.04	6.33	6.50
60	5.72	6.12	5.95	6.20	6.70	6.92
80	5.71	6.29	6.02	6.37	7.10	7.40

Interpolated from the original.



SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF HYDROCHLORIC  
AND OF ALKALI CHLORIDES AT 25°. (Herz, 1910.)

(The original results are given in millimols per 10 cc. They have been translated to gram quantities, plotted on cross-section paper and the following read from the curves.)

Gms. HCl or Alkali Chloride per 100 cc. Sat. Sol.	Gms. H <sub>3</sub> BO <sub>3</sub> Dissolved per 100 cc. Sat. Sol. in			
	HCl.	LiCl.	NaCl.	RbCl.
0	5.59	5.59	5.59	5.59
2	4.92	5.20	5.40	5.60
4	4.36	4.85	5.30	5.62
6	3.88	4.45	5.20	5.67
8	3.50	4.07	5.15	5.72
10	3.15	3.75	5.10	5.77
15	...	3	5.07	5.90
20	...	...	...	6.10
30	...	...	...	6.55

THE SYSTEM BORIC ACID, ACETIC ACID AND WATER AT 30°. (Duk

(The sat. solutions and residues were analyzed by titrating total acetic acid with 0.1 N NaOH and the acetic acid alone by an iodometric method.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		So
B <sub>2</sub> O <sub>3</sub> .	(CH <sub>3</sub> CO) <sub>2</sub> O.		B <sub>2</sub> O <sub>3</sub> .	(CH <sub>3</sub> CO) <sub>2</sub> O.		B <sub>2</sub> O <sub>3</sub> .	(CH <sub>3</sub> CO) <sub>2</sub> O.	
3.55	...	B(OH) <sub>3</sub>	1.01	73.96	B(OH) <sub>3</sub>	4.98	82.13	B <sub>2</sub> O <sub>3</sub> .
3.18	7.78	"	0.54	80.67	"	5.13	84.60	
2.98	16.44	"	0.45	84.55	" + (?)	5.41	85.68	
2.34	28.96	"	0.39	84.65	"	4.82	88.74	B <sub>2</sub> O <sub>3</sub> .
1.98	41.06	"	0.41	84.48	"	4.71	89.98	
1.47	52.63	"	0.46	84.44	"	4.06	92.68	
1.12	67.76	"	0.50	84.51	"	3.10	95.76	

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF:

Acetic Acid at 26°. (Herz, 1903a.)		Acetone at 20°. (Herz and B)	
Normality of Solutions.		Gms. per 100 cc. Solution.	
CH <sub>3</sub> COOH.	B(OH) <sub>3</sub> .	CH <sub>3</sub> COOH.	B(OH) <sub>3</sub> .
0	0.91	0	5.64
1	0.82	5	4.7
2	0.65	10	4.2
4	0.42	20	3.0
6	0.25	30	2.0
		cc. Acetone per 100 cc. Solvent.	B(OH) <sub>3</sub> per 100 Millimols.
		0	79.15
		20	81.71
		30	83.35
		40	82.72
		50	81.62
		60	76.40
		70	67.62
		80	55.05
		100	8.06

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF UREA, ACETIC ACID  
AND OF PROPYL ALCOHOL AT 25° (Bogdan.)

Grams of CO(NH <sub>2</sub> ) <sub>2</sub> , (CH <sub>3</sub> ) <sub>2</sub> CO or of C <sub>3</sub> H <sub>7</sub> OH per 100 Gms. H <sub>2</sub> O.	Gms. H <sub>3</sub> BO <sub>3</sub> per 100 g. H <sub>2</sub> O in Aq. Solutions of:		
	CO(NH <sub>2</sub> ) <sub>2</sub>	(CH <sub>3</sub> ) <sub>2</sub> CO.	C <sub>3</sub> H <sub>7</sub> OH.
0	5.75	5.75	5.75
10	5.84	5.84	5.80
20	5.93	5.93	5.85
40	6.13	6.12	5.94
60	6.31	6.29	6.03



SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF SEVERAL ALCOHOLS AT 25°.  
(Mueller and Abegg, 1906.)

In Aq. Methyl Alcohol.			In Aq. Ethyl Alcohol.			In Aq. Propyl Alcohol.		
Solvent.	Gms. $H_2BO_3$		Solvent.	Gms. $H_2BO_3$		Solvent.	$d_{25}^*$ of	Gms. $H_2BO_3$
$d_p$ Wt. % CH <sub>3</sub> OH.	per 100 cc. Sat. Sol.		$d_p$ Wt. % C <sub>2</sub> H <sub>5</sub> OH.	per 100 cc. Sat. Sol.		$d_p$ Wt. % C <sub>3</sub> H <sub>7</sub> OH.	Sat. Sol.	per 100 cc. Sat. Sol.
0.9691 19	5.55		0.9714 20.2	5.14		0.9043 50.83	0.9193	3.99
0.9340 41.5	6.27		0.9350 42.3	4.96		0.8231 79.41	0.8570	2.83
0.9185 50	6.81		0.8789 67.3	4.52		0.8133 95.5	0.8466	3.58
0.9019 58	7.20		0.8576 76.2	4.34		0.8010 100	0.8297	5.96
0.8842 66	8.10		0.8198 91.1	5.54				
0.7960 100	17.99*		0.8089 95	6.85				
			0.7947 100	9.47†				

\*  $d_{25}^* = 0.8904$ .†  $d_{25}^* = 0.8553$ .

In Aq. $\delta$ Butyl Alcohol			In Aq. $\delta$ Amyl Alcohol.		
Solvent.	$d_{25}^*$ of	Gms. $H_2BO_3$	Solvent.	$d_{25}^*$ of	Gms. $H_2BO_3$
$d_p$ Mol. % C <sub>4</sub> H <sub>9</sub> OH.	Sat. Sol.	per 100 cc. Sat. Sol.	$d_p$ Mol. % C <sub>5</sub> H <sub>11</sub> OH.	Sat. Sol.	per 100 cc. Sat. Sol.
0.9923 0.70	1.0124	5.48	0.9943 0.448	1.0132	5.48
0.9853 2.15	1.0038	5.32	0.9936 0.520	1.0125	5.46
0.9855 2.18	1.0046	5.32	0.9931 0.525*	1.0123	5.46
0.8173 71.4	0.8351	2	0.8232 67.26†	0.8290	1.60
0.8133 77.1	0.8220	2.15	0.8183 75.54	0.8253	1.69
0.8081 85.6	0.8195	2.61	0.8142 83.40	0.8223	1.98
0.7984 100	0.8172	4.30	0.8068 100	0.8220	3.54

\* = H<sub>2</sub>O sat. with amyl alcohol.† = Amyl alcohol sat. with H<sub>2</sub>O.

One liter H<sub>2</sub>O saturated with amyl alcohol dissolves 55.5 gms. H<sub>2</sub>BO<sub>3</sub> at 15°.  
(Auerbach, 1903.)

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF ETHYL  
ALCOHOL AT 15° AND AT 25°.  
(Seidell, 1908.)

## Results at 15°.

$d_p$ of Sat. Sol.	Gms. C <sub>2</sub> H <sub>5</sub> OH per 100 Gms. Solvent.	Gms. $H_2BO_3$ per 100 Gms. Sat. Sol.
1.014	0	4.11
0.9986	8.9	3.90
0.9658	32	3.58
0.9268	51	3.48
0.8820	70.2	3.22
0.8389	91.3	5.06
0.8370	93.6	5.70
0.8356	99.8	9.18

## Results at 25°.

$d_m$ of Sat. Sol.	Gms. C <sub>2</sub> H <sub>5</sub> OH per 100 Gms. Solvent.	Gms. per 100 Gms. $H_2BO_3$	Gms. Sat. Sol. C <sub>2</sub> H <sub>5</sub> OH.
1.018	0	5.42	0
0.987	20	5.20	18.06
0.952	40	5.10	37.96
0.908	60	5	57
0.862	80	5.05	75.96
0.853	85	5.30	80.50
0.842	90	6.20	84.4
0.838	95	8	87.4
0.838	100	11.20	88.8

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF LACTIC ACID,  
OXALIC ACID,  $\delta$  and  $\delta$  TARTARIC ACIDS AT 25°.

In Aq. Lactic Acid.  
(Mueller and Abegg, 1906.)In Aq. Oxalic Acid.  
(Herz, 1910.)In Aq.  $\delta$  and  $\delta$  Tartaric Acid.  
(Herz, 1911.)

Solvent.	$d_{25}^*$ of	Gms. $H_2BO_3$	Gms. per 100 cc.	Solid Phase.	Gms. per 100 cc. Sat. Sol.
$d_p$ Mol. % C <sub>3</sub> H <sub>5</sub> O <sub>3</sub> .	Sat. Sol.	per 100 cc. Sat. Sol.	Sat. Sol.		C <sub>3</sub> H <sub>5</sub> O <sub>3</sub> $H_2BO_3$
1.0252 2.321	1.0444	6.64	2.26 6.17	H <sub>2</sub> BO <sub>3</sub>	0 5.59
1.0722 6.819	1.0986	9.98	5.36 6.70	"	11.25 $\delta$ Acid 6.20
1.1405 18.77	1.1635	11.53	12.39 7.44	" + H <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	22.5 " 6.63
1.2023 36.33	1.2254	12.90	11.27 3.45	H <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	45 " 7.48
			10.84 0.97	"	9.45 $\delta$ Acid 6.11
			10.77 0.55	"	18.90 " 6.48
			10.63 0	"	37 " 7.23



SOLUBILITY OF BORIC ACID IN:

Pure Glycerol (Sp.Gr. = 1.260 at 15.5°). Aq. Solutions of Glyc at 25°.

Hooper — Pharm. J. Trans. [3] 13, 258, '82.) (Herz and Knoch — Z. anorg. Chem. 45, 268

t.°.	Gms. B <sub>2</sub> O <sub>3</sub> · 3H <sub>2</sub> O per 100 cc. Glycerine	Gms. B(OH) <sub>3</sub> per 100 Gms. Glycerine. Solution.		Wt. % Glycerine in Solvent.	Millimols B(OH) <sub>3</sub> per 100 cc. Sol.	Sp. Gr. at 25° 4°	Gms. B(OH) per 100 cc. Solution. Gr. h	
0	20	15.87	13.17	0	90.1	1.017	5.59	5
10	24	19.04	16.00	7.15	90.1	1.038	5.59	5
20	28	22.22	18.21	20.44	90.6	1.063	5.62	5
30	33	26.19	20.75	31.55	92.9	1.090	5.76	5
40	38	30.16	23.17	40.95	97.0	1.113	6.02	5
50	44	34.92	25.95	48.7	103.0	1.133	6.39	5
60	50	39.68	28.41	69.2	140.2	1.187	8.69	7
70	56	44.65	30.72	100.0	390.3	1.272	24.20	15
80	61	48.41	32.61					
90	67	53.18	34.70					
100	72	57.14	36.36					

IN AQUEOUS SOLUTIONS OF GLYCEROL AT 25°. AQUEOUS SOLUTIONS OF DUL AT 25°. (Mueller and Abegg, 1906.) (Mueller and Abegg, 1906.)

Solvent.			Gms. H <sub>3</sub> BO <sub>3</sub> per 100 cc. Sat. Sol.		Solvent.		Gms. H <sub>3</sub> BO <sub>3</sub> per 100 cc. Sat. Sol.	
d <sub>20</sub> <sup>4</sup> .	Mol. % C <sub>2</sub> H <sub>4</sub> O <sub>6</sub> .	Wt. % C <sub>2</sub> H <sub>4</sub> O <sub>6</sub> .	d <sub>20</sub> <sup>4</sup> of Sat. Sol.		d <sub>20</sub> <sup>4</sup> .	Mol. % C <sub>2</sub> H <sub>4</sub> (OH) <sub>4</sub> .	d <sub>20</sub> <sup>4</sup> of Sat. Sol.	
1.1574	24.64	60	1.1707	7.49	0.9995	0.065	1.0686	!
...	46.75	...	1.2260	13.22	1.0018	0.130	1.0212	!
1.2370	67.71	90	1.2526	18.35	1.0060	0.260	1.0260	!
1.2531	90.58	96.6	1.2710	23.44				

100 gms. glycerol (d<sub>15</sub> = 1.256) dissolve 11 gms. H<sub>3</sub>BO<sub>3</sub> at 15°-16°. (Ossendowski  
100 gms. dichlorethylene dissolve 0.006 gm. H<sub>3</sub>BO<sub>3</sub> at 15°. (Wester and Brunl  
100 gms. trichlorethylene dissolve 0.016 gm. H<sub>3</sub>BO<sub>3</sub> at 15°. "  
100 cc. anhydrous hydrazine dissolve 55 gms. H<sub>3</sub>BO<sub>3</sub> at room temp. (Welsh and Broderso

SOLUBILITY OF BORIC ACID IN AQUEOUS SOLUTIONS OF MANNITE AT AND VICE VERSA. (Ageno and Valla, 1912, 1913.)

Grams per 100 cc. Sat. Sol.		Solid Phase.	Gms. per 100 cc. Sat. Sol.		Solid Pha
H <sub>3</sub> BO <sub>3</sub> .	C <sub>6</sub> H <sub>14</sub> O <sub>6</sub> .		H <sub>3</sub> BO <sub>3</sub> .	C <sub>6</sub> H <sub>14</sub> O <sub>6</sub> .	
5.50	0	H <sub>3</sub> BO <sub>3</sub>	8.70	25.65	H <sub>3</sub> BO <sub>3</sub>
5.90	1.82	"	9.43	32.43	" + C <sub>6</sub>
6.29	5.46	"	7.71	27.97	C <sub>6</sub> H <sub>14</sub> (
6.44	7.28	"	5.75	25.65	"
6.64	9.11	"	4.92	24.65	"
6.83	10.93	"	3.46	23.03	"
7.08	12.75	"	2.87	22.98	"
7.27	14.57	"	1.64	20.80	"
7.71	18.99	"	0	19.58	"

Additional determinations at 30° also given.  
Determinations at 25°, differing somewhat from the above, are given by l and Abegg (1906).  
Data for the system boric acid, phenol and water are given by Timm (1907).



### DISTRIBUTION OF BORIC ACID BETWEEN WATER AND AMYL ALCOHOL AT 25°.

(Fox — Z. anorg. Chem. 35, 130, '03.)

Millimols B(OH) <sub>3</sub> in		Gms. B(OH) <sub>3</sub> in 100 cc.		Millimols B(OH) <sub>3</sub> in		Gms. B(OH) <sub>3</sub> in 100 cc.	
Aq. Layer.	Alcoholic Layer.	Aq. Layer.	Alcoholic Layer.	Aq. Layer.	Alcoholic Layer.	Aq. Layer.	Alcoholic Layer.
265.8	76.6	1.648	0.475	87.9	33.2	0.545	0.206
196.5	59.5	1.219	0.369	75.2	22.7	0.466	0.141
159.6	47.5	0.990	0.294	64.6	19.76	0.400	0.123
126.0	37.1	0.781	0.230				

### RESULTS AT 15°. (Mueller and Abegg, 1906.)

Millimols B(OH) <sub>3</sub> per Liter.		Gms. B(OH) <sub>3</sub> per 100 cc.		Millimols B(OH) <sub>3</sub> per Liter.		Gms. B(OH) <sub>3</sub> per 100 cc.	
Aq. Layer.	Alcohol Layer.	Aq. Layer.	Alcohol Layer.	Aq. Layer.	Alcohol Layer.	Aq. Layer.	Alcohol Layer.
804	264	5.44	1.64	427.4	127.6	2.65	0.79
607.2	176.4	3.76	1.09	372	110	2.31	0.68
589.3	177.4	3.65	1.10	289.1	84.9	1.79	0.53

Data agreeing with those of Fox at 25° are also given by Mueller and Abegg, 1906. One determination at 35° gave 0.907 gm. B(OH)<sub>3</sub> per 100 cc. aq. layer and 0.274 gm. per 100 cc. alcohol layer.

### DISTRIBUTION OF BORIC ACID BETWEEN AQUEOUS SODIUM CHLORIDE SOLUTIONS AND AMYL ALCOHOL AT 25°.

(Mueller and Abegg, 1906)

Gms. per 100 cc.:					Gms. per 100 cc.:				
Aq. Layer.		Alcohol Layer.		d <sub>20</sub> of	Aq. Layer.		Alcohol Layer.		d <sub>20</sub> of
KaCl.	H <sub>2</sub> BO <sub>3</sub> .	H <sub>2</sub> O.	H <sub>2</sub> BO <sub>3</sub> .	Alcohol Layer.	NaCl.	H <sub>2</sub> BO <sub>3</sub> .	H <sub>2</sub> O.	H <sub>2</sub> BO <sub>3</sub> .	Alcohol Layer.
0	5.46	7.39	1.65	0.8296	16.64	5.13	4.71	1.79	0.8247
5.53	5.37	6.40	1.65	0.8277	17.90	5.02	4.31	1.79	0.8241
8.72	5.27	5.90	1.67	0.8268	20.36	5.02	4.19	1.87	0.8240
10.91	5.23	5.46	1.69	0.8259	23.52	4.97	3.59	1.96	0.8233
13.84	5.16	5.15	1.77	0.8254	25.03	4.95	3.20	1.99	0.8229

### DISTRIBUTION OF BORIC ACID BETWEEN WATER AND MIXTURES OF AMYL ALCOHOL AND CARBON DISULFIDE AT 25°.

(Herz and Kurzer, 1910.)

75 Vol. % C <sub>5</sub> H <sub>11</sub> OH + 25 Vol. % CS <sub>2</sub> .			50 Vol. % C <sub>5</sub> H <sub>11</sub> OH + 50 Vol. % CS <sub>2</sub> .			25 Vol. % C <sub>5</sub> H <sub>11</sub> OH + 95 Vol. % CS <sub>2</sub> .		
Gms. H <sub>2</sub> BO <sub>3</sub> per 100 cc.			Gms. H <sub>2</sub> BO <sub>3</sub> per 100 cc.			Gms. H <sub>2</sub> BO <sub>3</sub> per 100 cc.		
Aqueous Layer.	C <sub>5</sub> H <sub>11</sub> OH + CS <sub>2</sub> Layer.		Aqueous Layer.	C <sub>5</sub> H <sub>11</sub> OH + CS <sub>2</sub> Layer.		Aqueous Layer.	C <sub>5</sub> H <sub>11</sub> OH + CS <sub>2</sub> Layer.	
0.387	0.095	0.469	0.095	0.433	0.053	0.743	0.171	0.839
0.743	0.171	0.839	0.161	0.910	0.108	1.143	0.266	1.207
1.590	0.365	1.791	0.344	1.940	0.238			

### BORIC ANHYDRIDE B<sub>2</sub>O<sub>3</sub>.

Fusion-point data (solubilities, see footnote, p. 1) are given for mixtures of B<sub>2</sub>O<sub>3</sub>+CaO and B<sub>2</sub>O<sub>3</sub>+SrO by Guertler (1904).

### BORIC ACID (Tetra) H<sub>2</sub>B<sub>4</sub>O<sub>7</sub>.

100 grams water dissolve 2.69 grams H<sub>2</sub>B<sub>4</sub>O<sub>7</sub> at 15°, Sp. Gr. = 1.015. (Gerlach, 1889.)

### BORON TRI-FLUORIDE BF<sub>3</sub>.

1 cc. H<sub>2</sub>O absorbs 1.057 cc. BF<sub>3</sub> at 0° and 762 mm.; 1 cc. conc. H<sub>2</sub>SO<sub>4</sub> (Sp. Gr. 1.85) absorbs 50 cc. BF<sub>3</sub>.



**BRASSIDIC ACID**  $C_8H_{17}CH:CHC_{11}H_{23}COOH$ .

Solubility data determined by the freezing-point method are given by Mercarelli and Sanna (1915), for mixtures of brassidic and erucic acids and brassidic and isoerucic acids.

**BROMAL HYDRATE**  $CBr_3 \cdot CH(OH)_2$ 

- The distribution coefficient of bromal hydrate between olive oil and water 0.665 at ord. temp. (Baum, 1899); 0.7 at ord. temp. (Meyer, 1909).

**BROMINE Br.**

## SOLUBILITY IN WATER.

(Winkler — Chem. Ztg. 23, 687, '99; Roozeboom — Rec. trav. chim. 3, 29, 59, 73, 84, '84; Dancer J. Chem. Soc. 15, 477, '62; at 15°, Dietze — Pharm. Ztg. 43, 290, '08.)

t°.	Grams Bromine per 100 Grams.				"Absorption Coefficient." * α.	"Solubility." g.
	Water. (W.)	(R. D. & D.)	Solution. (W.)	(R. D. & D.)		
0	4.17	4.22	3.98	4.05	60.5	43.1
5	3.92	3.7	3.77	3.57	45.8	32.4
10	3.74	3.4	3.61	3.29	35.1	24.8
15	3.65	3.25	3.52	3.15	27.0	19.0
20	3.58	3.20	3.46	3.10	21.3	14.8
25	3.48	3.17	3.36	3.07	17.0	11.7
30	3.44	3.13	3.32	3.03	13.8	9.4
40	3.45	...	3.33	...	9.4	6.2
50	3.52	...	3.40	...	6.5	4.0
60	...	...	...	...	4.9	2.8
80	...	...	...	...	3.0	1.1

\* For definition of "Absorption Coefficient" α and "Solubility" g, see Acetylene, p. 16.

One liter sat. solution of bromine in water contains 0.21 mol.  $Br_2 = 33$  gms. Br at 25°.

(Bray and Connolly, 19)

The coefficient of solubility of bromine in water at 15°, determined by aspiration method, is given as 33 by Jones (1911). This investigator also gives the figure 56 for the solubility coefficient in 25 vol. % acetic acid and 551 90 vol. % acetic acid at 15°.

Data for the distribution of bromine between water and air at 25°, are given by Hantzsch and Vagt (1901).

## SOLUBILITY OF BROMINE IN AQUEOUS SOLUTIONS OF MERCURIC BROMIDE AT 25° AND VICE VERSA.

(Herz and Paul, 1914.)

Gms. per 100 cc. Sat. Sol.		Solid Phase.	Gms. per 100 cc. Sat. Sol.		Solid Phase.
HgBr <sub>2</sub> .	Br.		HgBr <sub>2</sub> .	Br.	
0	3.40	$Br_2$	0.763	3.57	$Br_2 + HgBr_2$
0.202	3.53	"	0.701	2.88	$HgBr_2$
0.285	3.55	"	0.664	1.20	"
0.462	3.56	"			



**SOLUBILITY OF BROMINE IN AQUEOUS SOLUTIONS OF POTASSIUM BROMIDE.**

(Results at 0° and 25°, Boericke, 1905; at 0°, Jones and Hartmann, 1916; at 18.5° and 26.5°, Worley, 1905.)

Gm. Mole KBr per Liter.	Gms. KBr per Liter.	Gms. Bromine Dissolved per Liter of Sat. Solution at:			
		0°.	18.5°.	25°.	26.5°.
0	0	41.6 (24.2)	35.56	34	34.23
0.005	0.59	41.7 (25.5)	36.1	34.3	35.1
0.010	1.19	42.6 (26.2)	37	35	36
0.020	2.38	44.4 (27.5)	38.56	36.5	37.35
0.050	5.95	50.2 (31.5)	43.8	41	42.5
0.100	11.90	59.7 (40)	52.23	49.3	51.87
0.20	23.80	79.1 (57.1)	69.69	67.3	68.69
0.50	59.51	138.6 (111.9)	123	119	116
0.80	92.22	200 (174)	178.70	176	168.10
1	119.02	243.1 (217.5)	216	216.5	204
1.725	205.2	402.3 (395.9)	...	...	...
1.82	216.6	423.8 (423)	...	...	...
2.17	258.2	511.7 (511.7)	...	...	...
3.033	360.8	736.7 ...	...	632.4	...

Very accurate determinations at 0°, at concentrations of KBr below 0.01 normal, are given by Jones and Hartmann. Liquid bromine in contact with aqueous solutions at 0° is slowly converted to the hydrate,  $\text{Br}_2 \cdot 10\text{H}_2\text{O}$ , with a reduction in amount of dissolved bromine. At this temperature there are, consequently, two saturation concentrations. The unstable one being for solutions in contact with liquid bromine and the stable one being for solutions in contact with  $\text{Br}_2 \cdot 10\text{H}_2\text{O}$ . The results for the latter are shown in parentheses in the above table.

**SOLUBILITY OF BROMINE IN AQUEOUS SOLUTIONS OF POTASSIUM SULPHATE, SODIUM SULPHATE, AND OF SODIUM NITRATE AT 25°.**

(Jakowkin — Z. physik. Chem. 20, 38, '96.)

Normality of Salt Solution.	In $\text{K}_2\text{SO}_4$		In $\text{Na}_2\text{SO}_4$		In $\text{NaNO}_3$	
	Gms. per Liter.		Gms. per Liter.		Gms. per Liter.	
	$\text{K}_2\text{SO}_4$ .	Br.	$\text{Na}_2\text{SO}_4$ .	Br.	$\text{NaNO}_3$ .	Br.
1	91.18	25.14	63.55	25.07	85.09	28.80
1/2	45.59	29.44	31.77	29.20	42.54	31.35
1/3	22.79	31.46	15.88	31.33	21.27	32.62
1/4	11.39	32.70	7.94	32.94	10.63	33.33
1/5	5.69	33.10	3.97	33.26	5.31	33.74

**SOLUBILITY OF BROMINE IN AQUEOUS SALT SOLUTIONS AT 25°.**

(McLauchlan, 1903.)

Salt.	Gms. Salt per Liter.	Normality of Dis- solved Br.	Gms. Br. per Liter.	Salt.	Gms. Salt per Liter.	Normality of Dis- solved Br.	Gms. Br. per Liter.
Water	0.0	0.424	33.95	$\text{NH}_4\text{NO}_3$	80.11	0.688	55.15
$\text{Na}_2\text{SO}_4$	63.55	0.286	23.9	$\text{NaCl}$	58.50	0.701	55.90
$\text{K}_2\text{SO}_4$	91.18	0.310	24.8	$\text{KCl}$	74.60	0.718	57.40
$(\text{NH}_4)_2\text{SO}_4$	70.04	0.971	77.7	$\text{NH}_4\text{Cl}$	53.52	1.028	82.2
$\text{NaNO}_3$	85.09	0.3495	28.0	$\text{CH}_3\text{COONH}_4$	77.09	4.26	340.5
$\text{KNO}_3$	101.19	0.362	28.95	$\text{H}_2\text{SO}_4^*$	49.03	0.366	29.26

\* Wildeman.



## BROMINE

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SOLUBILITY OF BROMINE IN AQUEOUS SOLUTIONS OF SODIUM BROMIDE AT 25°.  
(Bell and Buckley, 1912.)

Grams per Liter Sat. Sol.		$d_m$ of Sat. Sol.	Gms. per Liter Sat. Sol.		$d_m$ of Sat. Sol.
NaBr.	Br.		NaBr.	Br.	
92.6	99.2	1.213	319.7	546	1.997
160.5	176.7	1.372	359	641.6	2.137
205.8	247.8	1.515	...	769.2	2.327
255.8	343	1.678	408.3	834	2.420

## RECIPROCAL SOLUBILITY OF BROMINE AND CHLORINE, BROMINE AND HYDROBROMIC ACID AND BROMINE AND SULFUR DIOXIDE, DETERMINED BY METHOD OF LOWERING OF THE FREEZING-POINT (see footnote, p. 1).

Results for Bromine + Chlorine.		Bromine + Hydrobromic Acid.			Bromine + Sulfur Dioxide.	
(Lebeau, 1906; see also Karsten, 1907.)		(Büchner and Karsten, 1908-09.)			(van der Goot, 1913.)	
t° of Melting.	Gms. Br per 100 Gms. Mixture.	t° of Melting.	Gms. Br per 100 Gms. Mixture.	Mol. % Br. in Mixture.	t° of Melting.	Gms. Br per 100 Gms. Mixture.
-102.5	0	-87.3	0	0	-75.1	0
-100	6.5	-90	6	2.5	-75.3*	1.73
-90	31	-95*	11.2	4.8	-60	4
-80	49.6	-90	11.8	5	-40	12.5
-70	60.4	-80	15.2	6.8	-30	21
-60	70	-70	22	11.5	-20	35.5
-50	79	-60	31.7	19	-18	40.5
-40	86.3	-50	43	30	-16	48
-30	91.1	-40	54.5	43.5	-14	72
-20	95.2	-30	66.2	60	-13	90
-10	89	-20	79.5	76.5	-10	96.5
-7.3	100	-12.5	90	90	-7.1	100

\* Eutec.

## SOLUBILITY DATA, DETERMINED BY THE FREEZING-POINT METHOD (see footnote, p. 1), ARE GIVEN FOR THE FOLLOWING MIXTURES:

Bromine + Methyl alcohol (Maass and McIntosh, 1912.)	
" + Ethyl alcohol	" "
" + Ethyl acetate	" "
" + Ethyl bromide	(Wroczyński and Guye, 1910.)
" + Iodine	(Meerum-Terwogt, 1905; Kruyt and Heldermann, 1916.)
" + Sulfur	(Ruff and Winterfeld, 1903.)

100 grams saturated solution of bromine in carbon disulfide contain 45.4 grams Br at -95°, 39 grams at -110.5°, and 36.9 grams at -116°.  
(Arctowski, 1895-1896.)

DISTRIBUTION OF BROMINE BETWEEN WATER AND CARBON TETRACHLORIDE  
AT 0°.

(Jones and Hartmann, 1916.)

Gm. Br per Gm. CCl <sub>4</sub> Solution.	Density CCl <sub>4</sub> -Br.	Gms. Bromine per Liter.		Gm. Br per Gm. CCl <sub>4</sub> Solution.	Density CCl <sub>4</sub> -Br.	Gms. Bromine per Liter.	
		H <sub>2</sub> O Layer.	CCl <sub>4</sub> Layer.			H <sub>2</sub> O Layer.	CCl <sub>4</sub> Layer.
0.01640	1.6454	1.28	26.99	0.07261	1.6896	5.35	122.82
0.01847	1.6470	1.44	30.45	0.08162	1.6972	6.03	138.66
0.05433	1.6755	4.12	91.12	0.08661	1.7012	6.30	184.41
0.06126	1.6809	4.59	103.07	0.1646	1.7667	11.22	291.10



## DISTRIBUTION OF BROMINE AT 25° BETWEEN WATER AND:

(Calculated from results of Jakowkin, 1895. Those in parentheses from Herz and Kurzer, 1910.)

Carbon Disulfide.		Bromoform.		Carbon Tetrachloride.	
Gms. Br. per Liter of:		Gms. Br. per Liter of:		Gms. Br. per Liter of:	
Aq. Layer.	CS <sub>2</sub> Layer.	Aq. Layer.	CHBr <sub>3</sub> Layer.	Aq. Layer.	CCl <sub>4</sub> Layer.
0.5	36 (35)	0.5	33	0.5	15 (13)
1	80 (75)	1	66	1	28 (23)
2	163 (155)	2	136	2	60 (45)
3	240 (230)	3	206	3	90 (70)
4	330 (310)	4	276	4	123 (95)
5	420 (395)	5	346	5	156 (122)
6	515 (480)	6	415	6	190 (150)
7	620 (565)	...	...	8	260 (220)
				10	340 (300)
				12	430 (400)
				14	520 (550?)

Lewis and Storch (1917) point out that Jakowkin (1896) failed to take into consideration, the hydrolysis of the bromine in the aqueous phase in the very dilute solutions. They used 0.001  $\pi$  HCl which prevents the hydrolysis but is presumably too dilute to affect the true solubility. The distribution coefficient found in this way, given in terms of mols. Br per 1000 gms. H<sub>2</sub>O, divided by the mol. fraction of Br in the CCl<sub>4</sub>, is 0.3705 at 25°. These authors also give a series of determinations of the distribution of bromine between 0.1  $\pi$  HBr and CCl<sub>4</sub> at 25°.

## DISTRIBUTION OF BROMINE BETWEEN WATER AND MIXTURES OF CARBON DISULFIDE AND CARBON TETRACHLORIDE AT 25°.

(Herz and Kurzer, 1910.)

25 Vol. % CS <sub>2</sub> + 75 Vol. % CCl <sub>4</sub> .		50 Vol. % CS <sub>2</sub> + 50 Vol. % CCl <sub>4</sub> .		75 Vol. % CS <sub>2</sub> + 25 Vol. % CCl <sub>4</sub> .	
Gms. Bromine per Liter.		Gms. Bromine per Liter.		Gms. Bromine per Liter.	
Aq. Layer.	CS <sub>2</sub> +CCl <sub>4</sub> Layer.	Aq. Layer.	CS <sub>2</sub> +CCl <sub>4</sub> Layer.	Aq. Layer.	CS <sub>2</sub> +CCl <sub>4</sub> Layer.
0.79	28.4	0.63	28.7	0.71	46
1.53	58.4	1.19	54.5	1.34	87.2
2.32	86.6	1.76	81.1	3.98	213.8
2.98	111.3	2.45	110.9	5.06	330.5
3.66	137.8	2.95	132.9	6.82	444.2
5.26	205.1	6.47	343.8		
7.95	324.9	7.97	447.7		
9.66	432.2				

## DISTRIBUTION OF BROMINE AT 25° (Herz and Rathmann, 1913) BETWEEN:

## Water and Tetrachlorethane.

Grams Bromine per Liter.	
Aq. Layer.	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub> Layer.
0.216	6.47
0.592	18.20
0.944	29.46
1.348	41.65
2.444	74.57

## Water and Pentachlorethane.

Gms. Bromine per Liter.	
Aq. Layer.	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub> Layer.
0.402	10.70
0.670	18.29
0.864	23.49
1.300	35.46
2.408	67.44



# BROMINE

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DATA FOR THE DISTRIBUTION OF BROMINE BETWEEN AQUEOUS SALT SOLUTIONS AND ORGANIC SOLVENTS ARE GIVEN BY THE FOLLOWING INVESTIGATORS:

Immiscible Solvents.	t°.	Authority.
Aqueous $\text{CdBr}_2 + \text{CCl}_4$	25	(Van Name and Brown, 1917.)
Aqueous $\text{CdBr}_2 \cdot 2\text{KBr} + \text{CCl}_4$	25	" "
Aqueous $\text{HBr} + \text{CCl}_4$	25	(Lewis and Storch, 1917.)
Aqueous $\text{HgBr}_2 + \text{CCl}_4$	25	(Hers and Paul, 1914; Van Name and Brown, 1917.)
Aqueous $\text{HgBr}_2 \cdot 2\text{KBr} + \text{CCl}_4$	25	(Van Name and Brown, 1917.)
Aqueous $\text{KBr} + \text{CCl}_4$	0	(Jones and Hartmann, 1916.)
Aqueous $\text{KBr} + \text{CS}_2$	32.6	(Roloff, 1894.)

## BROMOFORM $\text{CHBr}_3$ .

100 cc.  $\text{H}_2\text{O}$  dissolve 0.125 gm.  $\text{CHBr}_3$  at  $15^\circ\text{--}20^\circ$ . (Squire and Caines, 1905.)

SOLUBILITY (Freezing-point lowering data, see footnote, p. 1) FOR MIXTURES OF:

Bromoform and Liquid Carbon Dioxide. (Büchner, 1905-06.)		Bromoform and Toluene. (Baud, 1912.)		
t°.	Gms. $\text{CHBr}_3$ per 100 Gms. $\text{CH}_2\text{Br} + \text{CO}_2$ .	t° of Freezing.	Gms. $\text{CHBr}_3$ per 100 Gms. $\text{CHBr}_3 + \text{C}_6\text{H}_5\text{CH}_3$ .	Solid Phase.
-31	0	+ 7.7	100	$\text{CHBr}_3$
-32	3.7	-11.4	86.6	"
-30	4.9	-22.2	75.6	"
-16	13.5	-30.9	69.8	"
-8	24	-48.5	60.3	"
-5	35.2-67.7 quad. pt.			
-3.5	92.1			

## BRUCINE $\text{C}_{21}\text{H}_{25}(\text{OCH}_3)_2\text{N}_2\text{O}_2 \cdot 4\text{H}_2\text{O}$ .

SOLUBILITY OF BRUCINE IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. Brucine per 100 Gms. Sat. Sol.	Authority.
Water	18-22	0.056-0.125	(Müller, 1903; Squire and Caines, 1905; Zalai, 1910.)
Aniline	20	12	(Scholtz, 1912.)
Benzene	18-22	1.11-1.86	(Müller, 1903; Schaefer, 1913.)
Carbon Tetrachloride	18-22	0.08	" "
"	20	1.96	(Schindelmeiser, 1901; Gori, 1913.)
Chloroform	25	11.6	(Schaefer, 1913.)
Trichlor Ethylene	15	2.5	(Wester and Bruins, 1914.)
Ether	18-22	0.75	(Müller, 1903.)
Ethyl Acetate	18-22	4.20	"
Ethyl Alcohol	25	45.2	(Schaefer, 1913.)
Diethylamine	20	1.0	(Scholtz, 1912.)
Methyl Alcohol	25	55.0	(Schaefer, 1913.)
Petroleum Ether	18-22	0.055-0.088	(Müller, 1903; Zalai, 1910.)
Glycerol	18-22	2.2	(Müller, 1903.)
Pyridine	20	28	(Scholtz, 1912.)
"	20-25	21.0	(Dehn, 1917.)
Aq. 50% Pyridine	20-25	31.0	"
Piperidine	20	1	(Scholtz, 1912.)

Results for the solubility of brucine and brucine sulfate in mixtures of alcohol, chloroform and benzene are given by Schaefer (1913).

## BRUCINE Per CHLORATE $\text{C}_{21}\text{H}_{25}(\text{OCH}_3)_2\text{N}_2\text{O}_2 \cdot \text{HClO}_4$ .

100 gms.  $\text{H}_2\text{O}$  + 2%  $\text{HClO}_4$  dissolve 0.15 gm. of the salt at  $18^\circ$ .

(Hofmann, Roth, Höbold and Metzler, 1910.)



**BRUCINE SULFATE.**

100 cc. methyl alcohol	dissolve 0.28 gm. brucine sulfate at 25°.	(Schaefer, 1913.)
" ethyl "	" 1.66 " " " "	(Schaefer, 1913.)
" chloroform "	" 0.6 " " " "	(Schaefer, 1913.)

**BRUCINE *d*, *l*, and *i* TARTRATE.****SOLUBILITY OF EACH OPTICAL ISOMER IN WATER (Dutilh, 1912.)**

t°.	Gms. per 100 Gms. Water.		
	<i>d</i> Tartrate.	<i>l</i> Tartrate.	Racemic Tartrate.
20	...	...	1.38
25	1.008	1.84	...
35	1.272	3.24	...
44	1.590	4.64	...
50	1.854	6.56	...

**BUTANE C<sub>4</sub>H<sub>10</sub>.****SOLUBILITY IN WATER AT t° AND 760 MM.**

t°.	0°.	4°.	10°.	15°.	20°.
Vol. C <sub>4</sub> H <sub>10</sub> per 100 vols. H <sub>2</sub> O	3.147	2.77	2.355	2.147	2.065

**DiphenylBUTADIENE.**

Freezing-point curves (solubility, see footnote, p. 1), are given by Pascal (1914) for mixtures of diphenylbutadiene and each of the following compounds: diphenyldiacetylene, diphenylhydrazine and cinnamylidene.

**BUTYL ACETATE CH<sub>3</sub>CO<sub>2</sub>C<sub>4</sub>H<sub>9</sub>.****SOLUBILITY OF BUTYL ACETATE AND OF BUTYL FORMATE IN MIXTURES OF ALCOHOL AND WATER.**

(Bancroft — Calc. from Pfeiffer — Phys. Rev. 3, 205, '95-'96.)

cc. Alcohol in Mixture.	cc. H <sub>2</sub> O added to cause separation of a second phase in mixtures of the given quantity of alcohol and 3 cc. portions of:	
	Butyl Formate.	Butyl Acetate.
3	3.45	2.08
6	8.83	6.08
9	14.75	10.46
12	21.45	15.37
15	29.65	20.42
18	39.0	25.60
21	51.8	31.49
24	∞	37.48
27		43.75
30		50.74
33		59.97

100 cc. H<sub>2</sub>O dissolve 0.7 cc. isobutyl acetate at 25°.

(Bancroft.)

**IsobUTYL ACETATE, etc.****SOLUBILITY IN WATER. (Traube, 1884; at 20°, Vaubel, 1899.)**

t°.	Compound.	Grams Compound per 100 Grams H <sub>2</sub> O.
22	Iso Butyl Acetate	0.5
22	Iso Butyl Formate	1.0
20	Normal Butyric Aldehyde	3.6
20	Iso Butyric Aldehyde	10.0



Secondary **BUTYL ALCOHOL**  $\text{CH}_3\text{CHOH.CH}_2\text{CH}_3$ .Iso **BUTYL ALCOHOL**  $(\text{CH}_3)_2\text{CH.CH}_2\text{OH}$ .

## SOLUBILITY OF BUTYL ALCOHOLS IN WATER, "SYNTHETIC METHOD."

(see Note, p. 16).

(Alexejew, 1886.)

t°.	Secondary Butyl Alcohol and Water.		Iso Butyl Alcohol and Water.	
	Gms. Secondary Butyl Alcohol per 100 Gms. Aqueous Layer.	Alcoholic Layer.	Gms. Iso Butyl Alcohol per 100 Gms. Aqueous Layer.	Alcoholic Layer.
-20	27	66	...	...
-10	28	60	...	...
0	27.5	56	13	85
10	26.0	57	...	...
20	22.5	60	9	84
30	18	63.5	...	...
40	16	65.5	7.5	83
60	13	67	7	82
80	15	63	7	77.5
100	20	52	8	72
107 crit. temp.	33		...	...
120			16	62
130			28	50
133 crit. temp.				49

Additional determinations of the reciprocal solubility of secondary butyl alcohol and water are given by Dolgolenko (1908). This investigator prep three fractions of  $98^\circ\text{--}98.6^\circ$ ,  $98.6^\circ\text{--}99^\circ$  and  $99^\circ\text{--}99.5^\circ$  boiling point respectively and determined the curve for each fraction and water by the "synthetic method." The first fraction gave a closed curve having both a lower and an upper critical solution temperature, while the other fractions gave curves with only an upper critical solution temperature, and in other respects in fair agreement with results of Alexejew as shown in the above table. The explanation of this difference in the case of the first fraction, is supposed to be that this fraction contains a larger proportion of tertiary butyl alcohol than the others, due to the higher boiling point of this isomer. Since the tertiary alcohol is entirely miscible with secondary alcohol and water its presence would restrict the boundaries of inhomogeneity and, therefore, tend to favor a closed curve for the system.

SOLUBILITIES, DETERMINED BY THE FREEZING-POINT METHOD (see footnote, 1)  
ARE GIVEN FOR THE FOLLOWING MIXTURES CONTAINING BUTYL ALCOHOL

Isobutyl alcohol + Water	(Dreyer, 1913.)
" " + Liquid $\text{CO}_2$	(Büchner, 1905-06.)
Normal butyl alcohol + Water	(Dreyer, 1913.)
" " + Liquid $\text{CO}_2$	(Büchner, 1905-06.)
Secondary butyl alcohol + Water	(Dreyer, 1913; Timmermans, 1907, 1910,
" " + " + Hydroquinine	(Timmermans, 1907.)
Tertiary butyl alcohol + Water.	(Dreyer, 1913.)



**DISTRIBUTION OF ISOBUTYL ALCOHOL BETWEEN WATER AND COTTON SEED OIL AT 25°. (Wroth and Reid, 1916.)**

Gms. $C_4H_9OH$ per 100 cc.			Gms. $C_4H_9OH$ per 100 cc.		
Oil Layer.	H <sub>2</sub> O Layer.	Ratio.	Oil Layer.	H <sub>2</sub> O Layer.	Ratio
1.168	2.043	1.74	1.375	2.301	1.67
1.276	2.250	1.76	1.405	2.429	1.72
1.288	2.135	1.65	1.495	2.450	1.64

The partition coefficient of tertiary butyl alcohol  $(CH_3)_3C(OH)CH_3$ , between olive oil and water is given as 0.176 at ord. temp. (Baum, 1899.)

**ISOBUTYLAMINE HYDROCHLORIDE  $(CH_3)_2CHCH_2NH_2.HCl$ .**

100 gms. H<sub>2</sub>O dissolve 238.9 gms. of the salt at 25°. (Peddle and Turner, 1913.)

100 gms.  $CHCl_3$  dissolve 11.56 gms. of the salt at 25°. (Peddle and Turner, 1913.)

**BUTYLCHLORAL  $CH_3CHCl.CCl_2CHO$ .**

The distribution coefficient of butylchloral between oil and water is given as 1.6. (Meyer, 1907.)

**BUTYLCHLORALHYDRATE  $CH_3CHCl.CCl_2CH(OH)_2$ .**

100 gms. H<sub>2</sub>O dissolve 2.7 gms. butylchloralhydrate at 15.5° (Greenish and Smith, 1903.)

" " " 2.3 " " at 15°-20°. (Squire and Caines, 1905.)

" glycerol " 100 " " at 15°-20°. (Greenish and Smith, 1903.)

The partition coefficient of butylchloralhydrate between olive oil and water is given as 1.589 at ord. temp. (Baum, 1899.)

**BUTYRIC ACIDS (normal)  $CH_3(CH_2)_3COOH$ ; (iso)  $(CH_3)_2CH.COOH$ .**

**SOLUBILITY OF NORMAL BUTYRIC ACID IN WATER, DETERMINED BY THE FREEZING-POINT METHOD. (Faucon, 1909, 1910.)**

t° of Congealing.	Gms. Acid per 100 Gms. Mixture.	t° of Congealing.	Gms. Acid per 100 Gms. Mixture.	t° of Congealing.	Gms. Acid per 100 Gms. Mixture
0	0	-3.57	67.38	-13.40	87.62 Eutec.
-1.08	5.12	-5.20	75	-12.40	90.08
-2.70	12.75	-6.80	80	-10	95.92
-2.96	25.32	-8.61	84	-8	98.60
-3.07	50.60	-10.25	85.41	-5.40	99.15
-3.14	59.72	-12.54	86.54	-3.12	100

Higher values for the temperature of congealing of the above mixtures are given by Ballo (1910). For additional data see also Timmermans (1907) and Imbalotos (1914). Data for the miscibility of normal butyric acid and water are also given by Faucon. The curve is entirely in the metastable region. The mixtures are either opalescent or completely homogeneous and never form two distinct layers, even with the application of centrifugal force. The results are as follows:

t° of opalescence	-5.2	-4.2	-4	-3.8 crit. t.	-4.5	-7
Gms. acid per 100 gms. mixture	25	30	35	40	50	58.2

**SOLUBILITY OF ISOBUTYRIC ACID IN WATER, DETERMINED BY THE FREEZING-POINT METHOD. (Faucon, 1910.)**

The congealing temperatures for mixtures containing up to 60 grams iso-butyric acid per 100 gms. coincide with the results given in the above table for normal butyric acid and water. For higher concentrations the following results were obtained.

t° of congealing	-3.09	-3.35	-3.61	-12.5	-80
Gms. acid per 100 gms. mixture	70.10	82.08	86.44	97.21	100



MISCIBILITY OF ISOBUTYRIC ACID AND WATER, DETERMINED BY THE  
"SYNTHETIC METHOD."

(Smirnov, 1907.)

t°.	Gms. Acid per 100 Gms.:	
	Upper Layer.	Lower Layer.
10.05	69.08	17.82
12	67.1	18.3
14	64.9	19.1
16	62.3	20
18	59.2	21.1
20	55.4	22.8
22	49	25.8
22.5	46	27
23	41	29
23.3 crit. t.	34.7	

Determinations varying more or less from the above are given by Roth (1898), Friedlander (1901) and Faucon (1910). The discrepancies are shown by Smirnov to be due to the effect of variations in purity of the isobutyric acid; the position of the curve. Smirnov fractionated the purest obtainable acid and determined the miscibility curve for each fraction. The above results obtained with fraction 4 of boiling point 154°-155°, twice refractionated.

An extensive series of determinations are given by Smirnov of the effect of various percentages of different salts upon the temperature of immiscibility of an aqueous 16.46% isobutyric acid solution.

## DISTRIBUTION OF BUTYRIC ACID BETWEEN WATER AND BENZENE AT 13°

(Georgievics, 1913.)

Gms. Butyric Acid Used.	Gms. Acid Found per:	
	150 cc. Benzene Layer.	25 cc. H <sub>2</sub> O Layer.
2.0044	1.7643	0.2401
2.9968	2.6965	0.3003
3.5028	3.1740	0.3288
4.0088	3.6544	0.3544
4.5342	4.1521	0.3821

The distribution ratio of normal butyric acid between water and benzene at room temperature was found by King and Narracott (1909), to be 1 to 0.810 and for isobutyric acid, the ratio was 1 to 0.810.

One determination of the distribution of butyric acid between sat. aq. CaCl<sub>2</sub> solution and kerosene gave 7.2 gms. acid per 100 gms. aqueous layer and 92.8 gms. per 100 gms. kerosene layer at ord. temp. (Crowell,

## DATA FOR THE FOLLOWING TERNARY SYSTEMS CONTAINING NORMAL BUTYRIC ACID ARE GIVEN BY TIMMERMAN, 1907.

Normal Butyric acid	+	Water	+	Azobenzene.
"	"	"	"	+ Barium nitrate.
"	"	"	"	+ Benzophenone.
"	"	"	"	+ Camphor.
"	"	"	"	+ Cane sugar.
"	"	"	"	+ Mannite.
"	"	"	"	+ Naphthalene.
"	"	"	"	+ Potassium sulfate.
"	"	"	"	+ Sodium chloride.

Freezing-point data are given for mixtures of *n* butyric acid and formamide by English and Turner (1915), and for mixtures of trichlorobutyric acid and dipyrone by Kendall (1914).



**CADMIUM BROMIDE**  $\text{CdBr}_2$ .

## SOLUBILITY IN WATER.

ietz — Ber. 32, 95, '90; Z. anorg. Chem. 20, 260, '90; Wiss. Abb. p.t. Reichanstalt. 3, 433, '00; see also Eder — Dingler polyt. J. 221, 189, '76; Etard — Ann. chim. phys. [7] 2, 536, '94.)

t°.	Gms. $\text{CdBr}_2$ per 100 Gms. Solution.	Mols. $\text{CdBr}_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{CdBr}_2$ per 100 Gms. Solution.	Mols. $\text{CdBr}_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
0	37.92	4.04	$\text{CdBr}_2 \cdot 4\text{H}_2\text{O}$	40	60.65	10.20	$\text{CdBr}_2 \cdot \text{H}_2\text{O}$
18	48.90	6.21	"	45	60.75	10.24	"
30	56.90	8.73	"	60	61.10	10.39	"
38	61.84	10.73	"	80	62.29	10.48	"
35	60.29	10.05	$\text{CdBr}_2 \cdot \text{H}_2\text{O}$	100	61.63	10.63	"

Density of saturated solution at  $18^\circ = 1.683$ .

## SOLUBILITY OF CADMIUM BROMIDE IN ALCOHOL, ETHER, ETC.

100 gms. sat. solution of  $\text{CdBr}_2 \cdot 4\text{H}_2\text{O}$  in abs. alcohol contain 20.93 gms.  $\text{CdBr}_2$  at  $15^\circ$ . (Eder.)

100 gms. sat. solution of  $\text{CdBr}_2 \cdot 4\text{H}_2\text{O}$  in abs. ether contain 0.4 gm.  $\text{CdBr}_2$  at  $15^\circ$ . (Eder.)

100 gms. absolute acetone dissolve 1.559 gms.  $\text{CdBr}_2$  at  $18^\circ$ . d<sub>4</sub><sup>18</sup> sat. sol. = 0.873. (Naumann, 1904.)

100 gms. benzonitrile dissolve 0.857 gm.  $\text{CdBr}_2$  at  $18^\circ$ . (Naumann, 1914.)

100 gms. anhydrous hydrazine dissolve 40 gm.  $\text{CdBr}_2$  at room temp. (Welsh and Broderson, 1915.)

RECIPROCAL SOLUBILITIES, DETERMINED BY THE METHOD OF LOWERING OF THE FREEZING-POINT (see footnote, p. 1), ARE GIVEN FOR THE FOLLOWING MIXTURES:

Cadmium Bromide	+	Cadmium Chloride	(Nacken, 1907; Ruff and Plato, 1903.)
"	"	+ Cadmium Iodide	(Nacken, 1907.)
"	"	+ Calcium Fluoride	(Ruff and Plato, 1903.)
"	"	+ Cuprous Bromide	(Herrmann, 1911.)
"	"	+ Potassium Bromide	(Brand, 1913.)
"	"	+ Sodium Bromide	"
"	"	+ " " + Potassium Bromide	"

**CADMIUM (Mono)AMMONIUM BROMIDE**  $\text{CdBr}_2 \cdot \text{NH}_4\text{Br}$ 

## SOLUBILITY IN WATER.

(Rimbach, 1905; Eder.)

t°.	100 Grams Solution contain Gms.			Atomic Relation.			G. $\text{CdBr}_2 \cdot \text{NH}_4\text{Br}$ per 100 Gms. Solution.
	Cd.	Br.	$\text{NH}_4$ .	Cd	Br	$\text{NH}_4$ .	
1.0	16.33	34.87	2.63	1	3	1	53.82
14.8	17.40	37.15	2.80	1	3	1	58.01
52.2	19.79	42.38	3.21	1	3	1	65.31
110.1	22.99	49.17	3.72	1	3	1	75.98

100 gms. sat. solution of  $\text{CdBr}_2 \cdot \text{NH}_4\text{Br}$  in abs. alcohol contain 15.8 gms. double salt at  $15^\circ$  (Eder).

100 gms. sat. solution of  $\text{CdBr}_2 \cdot \text{NH}_4\text{Br}$  in abs. ether contain 0.36 gm. double salt at  $15^\circ$  (Eder).

**CACODYLIC ACID**  $(\text{CH}_3)_2\text{AsO.OH}$ .

100 cc.  $\text{H}_2\text{O}$  dissolve about 200 gms. cacodylic acid at  $15^\circ$ . (Squire and Caines, 1905.)

100 cc. 90% alcohol dissolve about 28.5 gms. cacodylic acid at  $15^\circ$ . "



**CADMIUM BROMIDE**

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**CADMIUM (Tetra) AMMONIUM BROMIDE**  $\text{CdBr}_2 \cdot 4\text{NH}_4\text{Br}$ .**SOLUBILITY IN WATER.**

(Rimbach.)

The double salt is decomposed by water at temperatures below  $160^\circ$ .

$t^\circ$	100 Gms. Solution contain Gms.			Atomic Relation in Sol.			Atomic Relation in Solid.		
	Cd.	Br.	$\text{NH}_4$	Cd	Br	$\text{NH}_4$	Cd	Br	$\text{NH}_4$
0.8	14.72	50.46	6.67	1	4.82	2.82	1	10.02	8.02
13.0	14.95	51.48	6.85	1	4.85	2.85	1	11.57	9.57
44.0	15.01	53.85	7.35	1	5.04	3.04	1	6.84	4.84
76.4	14.6	55.28	7.80	1	5.32	3.32	1	6.63	4.63
123.5	15.5	59.50	8.45	1	5.38	3.38	1	7.40	5.40
160.0	14.7	62.67	9.43	1	5.99	3.99	1	6.03	4.03

**CADMIUM (Mono) POTASSIUM BROMIDE**  $\text{CdBr}_2 \cdot \text{KBr} \cdot \text{H}_2\text{O}$ .**SOLUBILITY IN WATER.**

(Rimbach; see also Eder.)

$t^\circ$	100 Gms. Solution contain Gms.			Atomic Relation in Sol.			Gms. $\text{CdBr}_2 \cdot \text{KBr}$ per 100 Gms. Solution.
	Cd.	Br.	K.	Cd	Br	K.	
0.4	15.41	33.0	5.42	1	3	1	53.63
15.8	16.85	35.96	5.86	1	3	1	58.61
50.0	19.58	41.86	6.85	1	3	1	67.87
112.5	22.24	48.28	8.14	0.98	3	1.03	78.11

**CADMIUM TetraPOTASSIUM BROMIDE** is decomposed by water at ordinary temperatures.**CADMIUM (Mono)RUBIDIUM BROMIDE**  $\text{CdBr}_2 \cdot \text{RbBr}$ .**SOLUBILITY IN WATER.**

(Rimbach.)

$t^\circ$	100 Gms. Solution contain Gms.			Atomic Relation in Sol.			Gms. $\text{CdBr}_2 \cdot \text{RbBr}$ per 100 Gms. Solution.
	Cd.	Br.	Rb.	Cd	Br	Rb.	
0.4	8.37	17.93	6.43	1	3	1.01	32.65
14.5	10.72	23.02	8.30	0.99	3	1.01	41.87
49.2	15.01	32.13	11.51	1	3	1	58.54
107.5	19.65	41.12	14.06	1.02	3	0.96	75.77

**CADMIUM (Tetra)RUBIDIUM BROMIDE**  $\text{CdBr}_2 \cdot 4\text{RbBr}$ .**SOLUBILITY IN WATER.**

(Rimbach.)

$t^\circ$	100 Gms. Solution contain Gms.			Atomic Relation in Sol.			Gms. $\text{CdBr}_2 \cdot 4\text{RbBr}$ per 100 Gms. Solution.
	Cd	Br	Rb.	Cd	Br	Rb.	
0.5	5.70	24.94	17.97	0.98	6	4.05	47.95
13.5	6.55	28.74	20.74	0.97	6	4.05	55.17
51.5	8.25	35.51	25.39	0.99	6	4.02	68.82
114.5	9.50	40.67	29.00	1.00	6	4.0	79.04



**DIUM (Mono) SODIUM BROMIDE**  $\text{CdBr}_2 \cdot \text{NaBr} \cdot \frac{1}{2} \text{H}_2\text{O}$ .

SOLUBILITY IN WATER, ETC., AT 15°.

(Eder — Ding. polyt. J. 221, 189, '76.)

Solvent.	Gms. $\text{CdBr}_2 \cdot \text{NaBr}$ per 100 Gms.		Solid Phase.
	Solution.	Solvent.	
Water	49.0	96.1	$\text{CdBr}_2 \cdot \text{NaBr} \cdot \frac{1}{2} \text{H}_2\text{O}$
Absolute Alcohol	21.2	27.0	"
Absolute Ether	0.52	0.53	"

**DIUM CHLORATE**  $\text{Cd}(\text{ClO}_3)_2 \cdot 2\text{H}_2\text{O}$ .

SOLUBILITY IN WATER.

(Meusser, 1902.)

t°.	Gms. $\text{Cd}(\text{ClO}_3)_2$ per 100 Gms.		Solid Phase.	t°.	Gms. $\text{Cd}(\text{ClO}_3)_2$ per 100 Gms.		Solid Phase.
	Solution.	Mols. $\text{Cd}(\text{ClO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .			Solution.	Mols. $\text{Cd}(\text{ClO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	
6.5	26.18	3.07	Ice	± 0	74.95	25.92	$\text{Cd}(\text{ClO}_3)_2 \cdot 2\text{H}_2\text{O}$
3.0	52.36	9.52	"	18	76.36	27.98	"
0.0	72.10	22.47	$\text{Cd}(\text{ClO}_3)_2 \cdot 2\text{H}_2\text{O}$	49	80.08	34.82	"
5.0	72.53	22.87	"	65	82.95	42.14	"

Density of the sat. solution at 18° = 2.284.

**DIUM CHLORIDE**  $\text{CdCl}_2 \cdot 2\frac{1}{2} \text{H}_2\text{O}$ .

SOLUBILITY IN WATER.

— W. Abh. p. t. Reichanstalt 3, 433, '00; above 100°, Etard — Ann. chim. phys. [7] 2, 536, '94.)

G.	CdCl <sub>2</sub> per 100 Gms.		Solid Phase.	t°.	CdCl <sub>2</sub> per 100 Gms.		Solid Phase.
	Solution.	Mols. CdCl <sub>2</sub> per 100 Mols. H <sub>2</sub> O.			Solution.	Mols. CdCl <sub>2</sub> per 100 Mols. H <sub>2</sub> O.	
10	43.58	7.5	$\text{CdCl}_2 \cdot 4\text{H}_2\text{O}$	+10	57.47	13.3	$\text{CdCl}_2 \cdot \text{H}_2\text{O}$
0	49.39	9.6		20	57.35	13.2	
0	55.58	12.3		40	57.51	13.3	
5	59.12	14.2		60	57.71	13.4	
0	44.35	7.8	$\text{CdCl}_2 \cdot 2\frac{1}{2} \text{H}_2\text{O}$ (monoclinic)	80	58.41	13.8	
0	47.37	9.0		100	59.52	14.4	
18	52.53	10.9		150	64.8		
30	56.91	12.8		200	72.0		
36	57.91	13.5		270	77.7		

Density of saturated solution at 18° = 1.741.

100 gms. abs. ethyl alcohol dissolve 1.52 gms.  $\text{CdCl}_2$  at 15°.100 gms. abs. methyl alcohol dissolve 1.71 gms.  $\text{CdCl}_2$  at 15°. (de Bruyn, 1892.)100 gms. abs. methyl alcohol dissolve 1.5 gms.  $\text{CdCl}_2$  at the crit. temp.100 gms. benzonitrile dissolve 0.063 gm.  $\text{CdCl}_2$  at 18°. (Centnerszwer, 1910.)

(Naumann, 1914.)



# **CADMIUM CHLORIDE**

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RECIPROCAL SOLUBILITIES, DETERMINED BY THE METHOD OF LOWERING OF THE FREEZING-POINT (see footnote, p. 1), ARE GIVEN FOR THE FOLLOWING MIXTURES:

Cadmium Chloride	+	Cadmium Iodide	(Nacken, 1907 (c); Ruff and Plato, 1903.)
"	"	+ Cadmium Fluoride	(Ruff and Plato, 1903.)
"	"	+ Cadmium Sulfate	"
"	"	+ Calcium Chloride	(Sandonnini, 1911, 1914; Menge, 1911.)
"	"	+ Cuprous Chloride	(Herrmann, 1911.)
"	"	+ Lead Chloride	(Sandonnini, 1912, 1914; Herrmann, 1911.)
"	"	+ Magnesium Chloride	(Menge, 1911.)
"	"	+ Manganese Chloride	(Sandonnini, 1914; Sandonnini and Scarpa, 1911.)
"	"	+ Mercuric Iodide	(Sandonnini, 1912.)
"	"	+ Potassium Chloride	(Brand, 1911.)
"	"	+ Sodium Chloride	"
"	"	+ " " + Potassium Chloride	(Brand, 1911.)
"	"	+ Strontium Chloride	(Sandonnini, 1911; 1914.)
"	"	+ Thallium Chloride	(Korring, 1914; Sandonnini, 1913.)
"	"	+ Tin (ous) Chloride	(Herrmann, 1911; Sandonnini, 1914.)
"	"	+ Zinc Chloride	(Herrmann, 1911.)

## **CADMIUM AMMONIUM CHLORIDE $\text{CdCl}_2 \cdot \text{NH}_4\text{Cl}$**

### SOLUBILITY IN WATER.

(Rimbach — Ber. 30, 3075, 1897.)

t°.	100 Gms. Solution contain Gms.			Gms. $\text{CdCl}_2 \cdot \text{NH}_4\text{Cl}$ per 100 Gms.	
	Cd.	Cl.	$\text{NH}_4$ .	Solution.	Water.
2.4	14.26	13.44	2.24	29.94	42.74
16.0	15.82	15.07	2.56	33.45	50.26
41.2	18.61	17.46	2.89	38.96	63.83
63.8	20.92	19.73	3.34	43.99	78.54
105.9	24.70	23.52	4.01	52.23	109.33

## **CADMIUM (Tetra) AMMONIUM CHLORIDE $\text{CdCl}_2 \cdot 4\text{NH}_4\text{Cl}$**

### IN CONTACT WITH WATER.

The salt is decomposed in aqueous solution.

(Rimbach.)

t°.	100 Gms. Solution contain Gms.			Atomic Relation in Solution.		
	Cd.	Cl.	$\text{NH}_4$ .	Cd	Cl	$\text{NH}_4$ .
3.9	5.75	18.17	7.37	1	9.96	7.96
16.1	6.96	20.26	7.97	1	9.20	7.13
40.2	9.91	23.84	8.92	1	7.61	5.61
58.5	12.50	26.53	9.35	1	6.71	4.66
112.9	16.66	31.79	10.78	1	6.02	4.02
113.9	16.51	32.71	11.30	1	6.26	4.26

## **SOLUBILITY OF MIXTURES OF CADMIUM TETRA AMMONIUM CHLORIDE AND CADMIUM AMMONIUM CHLORIDE IN WATER.**

(Rimbach — Ber. 35, 1300, '02.)

t°.	100 Gms. Solution contain Gms.			Atomic Relation.			Solid Phase, Mol. per cent of:	
	Cd.	Cl.	$\text{NH}_4$ .	Cd	Cl	$\text{NH}_4$ .	$\text{CdCl}_2 \cdot 4\text{NH}_4\text{Cl}$	$\text{CdCl}_2 \cdot \text{NH}_4\text{Cl}$
1.1	5.34	17.62	7.27	1	10.47	8.50	49.6	50.4
14.0	7.12	19.86	7.84	1	8.84	6.87	47.0	53.0
40.7	10.24	23.82	8.85	1	7.37	5.37	77.0	23.0
58.5	12.50	26.53	9.35	1	6.71	4.66	...	...



**SOLUBILITY OF MIXTURES OF CADMIUM TETRA AMMONIUM CHLORIDE  
AND AMMONIUM CHLORIDE IN WATER.**

(Rimbach.)

t°.	100 Gms. Solution contain Gms.			Atomic Relation.			Solid Phase, Mol. per cent of:	
	Cd.	Cl.	NH <sub>4</sub> .	Cd	Cl	NH <sub>4</sub> .	NH <sub>4</sub> Cl.	CdCl <sub>2</sub> ·4NH <sub>4</sub> Cl.
1.0	2.82	17.11	7.82	1	19.21	17.28	59.0	41.0
13.2	2.76	18.84	8.71	1	21.62	19.62	74.0	26.0
10.1	3.16	22.56	10.49	1	22.65	20.74	71.0	29.0
18.2	3.51	25.21	11.72	1	22.79	20.89	69.0	31.0

**CADMIUM BARIUM CHLORIDE 2(CdCl<sub>2</sub>)·BaCl<sub>2</sub>·5H<sub>2</sub>O.**

**SOLUBILITY IN WATER.**

(Rimbach — Ber. 30, 3083, '97.)

t°.	100 Gms. Solution contain Gms.			Gms. 2(CdCl <sub>2</sub> )·BaCl <sub>2</sub> per 100 Gms.	
	Cd.	Cl.	Ba.	Solution.	Water.
22.6	17.71	16.89	11.0	45.60	83.82
41.3	19.22	18.15	11.77	49.14	96.62
53.9	19.85	18.75	12.41	51.04	104.25
62.2	20.59	19.66	12.83	53.08	113.13
69.5	21.20	20.18	13.09	54.47	119.64
107.2	24.25	23.23	14.90	62.38	165.85

**CADMIUM BARIUM CHLORIDE CdCl<sub>2</sub>·BaCl<sub>2</sub>·4H<sub>2</sub>O.**

**SOLUBILITY IN WATER.**

(Rimbach.)

t°.	100 Gms. Solution contain Gms.			Gms. CdCl <sub>2</sub> ·BaCl <sub>2</sub> per 100 Gms.	
	Cd.	Cl.	Ba.	Solution.	Water.
22.5	11.98	15.19	14.71	41.88	72.06
32.9	12.40	16.18	16.09	44.67	80.73
41.4	13.05	16.95	16.81	46.81	88.01
53.4	13.96	18.21	18.13	50.30	101.21
62.0	14.73	18.81	18.74	52.28	109.56
97.8	17.57	22.48	22.00	62.05	163.50
108.3	18.53	23.51	22.79	64.83	184.33
109.2	18.67	23.69	29.95	65.31	188.27

**CADMIUM MAGNESIUM CHLORIDE 2(CdCl<sub>2</sub>)·MgCl<sub>2</sub>·12H<sub>2</sub>O.**

**SOLUBILITY IN WATER.**

(Rimbach.)

t°.	100 Gms. Solution contain Gms.			Gms. 2(CdCl <sub>2</sub> )·MgCl <sub>2</sub> per 100 Gms.	
	Cd.	Cl.	Mg.	Solution.	Water.
2.4	22.14	21.06	2.41	45.61	83.86
20.8	24.30	22.80	2.55	49.69	98.77
45.5	26.24	24.55	2.72	53.51	115.10
67.2	28.45	26.71	2.98	58.14	138.90
121.8	31.84	30.20	3.44	65.48	189.69



# **CADMIUM CHLORIDE**

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## **CADMIUM (Mono)RUBIDIUM CHLORIDE $\text{CdCl}_2 \cdot \text{RbCl}$**

SOLUBILITY OF CADMIUM MONORUBIDIUM CHLORIDE IN WATER.  
(Rimbach, 1902.)

t°.	100 Gms. Solution contain Gms.			Gms. $\text{CdCl}_2 \cdot \text{RbCl}$ per 100 Gms.	
	Cd.	Cl.	Rb.	Solution.	Water.
1.2	4.80	4.53	3.63	12.97	14.90
14.5	6.20	5.88	4.75	16.80	20.19
41.4	9.34	8.86	7.14	25.31	33.89
57.6	11.40	10.78	8.63	30.83	44.58
103.9	17.14	16.37	13.39	46.62	87.36

## **CADMIUM (Tetra)RUBIDIUM CHLORIDE $\text{CdCl}_2 \cdot 4\text{RbCl}$**

IN CONTACT WITH WATER.  
(Rimbach.)

The double salt decomposes to  $\text{CdCl}_2 \cdot \text{RbCl}$  and  $\text{RbCl}$ .

t°.	100 Gms. Solution contain Gms.			Atomic Relation.			Solid Phase, Mol. per cent.	
	Cd.	Cl.	Rb.	Cd	Cl	Rb.	$\text{CdCl}_2 \cdot \text{RbCl}$	$\text{CdCl}_2 \cdot 4\text{RbCl}$
0.7	0.65	6.52	14.73	1	31.88	29.88	30	70
8.8	1.07	7.37	16.13	1	21.89	19.89	24	76
13.8	1.32	7.86	16.93	1	18.88	16.83	16	84
42.4	3.21	11.35	22.45	1	11.21	9.21	14	86
59.0	4.61	13.41	25.31	1	9.23	7.23	33	67
108.4	8.94	18.57	31.15	1	6.57	4.59	..	..

SOLUBILITY OF MIXTURES OF  $\text{CdCl}_2 \cdot 4\text{RbCl}$  AND  $\text{RbCl}$  IN WATER  
(Rimbach.)

t°.	100 Gms. Solution contain Gms.			Atomic Relation.			Solid Phase, Mol. per cent.	
	Cd.	Cl.	Rb.	Cd	Cl	Rb.	$\text{CdCl}_2 \cdot 4\text{RbCl}$	$\text{RbCl}$
0.4	..	12.86	30.97	..	1	1	55	45
14.8	..	13.62	32.81	..	1	1	67	33
17.9	..	14.0	33.71	..	1	1	80	20

THE EFFECT OF THE PRESENCE OF  $\text{HCl}$ ,  $\text{CaCl}_2$  AND OF  $\text{LiCl}$  UPON THE DECOMPOSITION OF CADMIUM TETRARUBIDIUM CHLORIDE BY WATER AT 16°.  
(Rimbach, 1905.)

100 Gms. Solution contain Gms.					Mols. per 100 Mols. $\text{H}_2\text{O}$ .			Molecular Ratio	
Total Cl.	Cl.	$\text{HCl}$ .	Cd.	Rb.	$\text{CdCl}_2$ .	$\text{RbCl}$ .	$\text{HCl}$ .	$\text{CdCl}_2$ :	$\text{RbCl}$
36.44	0.84	36.61	0.41	1.39	0.109	0.483	29.76	1	4.43
28.45	0.80	28.44	0.35	1.38	0.082	0.422	20.35	1	5.15
12.09	3.24	9.11	0.69	6.74	0.139	1.772	5.60	1	12.75
	Ca.	$\text{CaCl}_2$ .					$\text{CaCl}_2$ .		
14.98	7.56	20.91	0.73	2.80	0.159	0.799	4.59	1	5.04
12.70	5.77	15.96	0.77	4.87	0.163	1.353	3.41	1	8.31
10.85	3.78	14.47	1.00	8.51	0.211	2.365	2.24	1	11.21
9.08	1.84	5.10	1.24	12.14	0.262	3.385	1.09	1	12.9
	Li.	$\text{LiCl}$ .					$\text{LiCl}$ .		
26.49	4.87	29.40	0.56	3.871	0.139	1.271	19.40	1	9.1
20.37	3.33	20.11	0.52	7.84	0.122	2.433	12.54	1	19.1

See Note on next page.



**CADMIUM (Mono) POTASSIUM CHLORIDE**  $\text{CdCl}_2 \cdot \text{KCl} \cdot \text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Rimbach—Ber. 30, 3079, '97; see also Croft—Phil. Mag. [3] 21, 356, '42.)

t°.	100 Gms. Solution contain Gms.			Gms. $\text{CdCl}_2 \cdot \text{KCl}$ per 100 Gms.	
	Cd.	Cl.	K.	Solution.	Water.
2.6	9.53	9.03	3.31	21.87	27.99
15.9	11.63	10.98	3.99	26.60	36.24
41.5	15.47	14.73	5.45	35.66	55.34
60.6	17.68	16.80	6.20	40.67	68.55
105.1	22.46	21.34	7.87	51.67	106.91

**CADMIUM (Tetra) POTASSIUM CHLORIDE**  $\text{CdCl}_2 \cdot 4\text{KCl}$ .

## IN CONTACT WITH WATER.

(Rimbach.)

The double salt is decomposed when dissolved in water at ordinary temperature.

t°.	100 Grams Solution contain Gms.		
	Cd.	Cl.	K.
4	3.64	9.84	8.31
23.6	5.66	14.02	11.52
50.2	9.10	18.09	13.60
108.9	11.94	23.11	17.16

NOTE.—The effect of the presence of certain chlorides upon the decomposition of cadmium tetra potassium chloride by water at 16° was investigated by Rimbach in a manner similar to that used in the case of cadmium tetra rubidium chloride (see preceding page). The results, which show the extent to which increasing amounts of the several chlorides force back the decomposition of the double salt, were plotted on cross-section paper, and the points at which the decomposition was prevented, were determined by interpolation. These values which show the minimum amount of the added chlorides which must be present to insure the crystallization of the pure double salt are shown in the following table.

Added Chloride.	Mols. per 100 Mols. $\text{H}_2\text{O}$ .			Density of Solutions.	Mols. per Liter of Solution.		
	$\text{CdCl}_2$ .	KCl.	Added Chloride.		$\text{CdCl}_2$ .	KCl.	Added Chloride.
HCl	0.074	0.296	19.80	1.1403	0.033	0.132	8.828
LiCl	0.344	1.376	9.30	1.1380	0.166	0.663	4.483
$\text{CaCl}_2$	0.544	2.176	3.80	1.2333	0.270	1.080	1.887
KCl	1.034	6.514*	2.378	1.214	0.507	3.195*	1.167

\* Total.



# **CADMIUM CHLORIDE**

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## **SOLUBILITY OF CADMIUM CHLORIDE IN AQUEOUS SOLUTIONS OF F CHLORIDE AT SEVERAL TEMPERATURES AND VICE VERSA. (Sudhaus**

Gms. per 100 gms. H <sub>2</sub> O.		Solid Phase.	Gms. per 100 gms. H <sub>2</sub> O.		Solid
CdCl <sub>2</sub> .	KCl.		CdCl <sub>2</sub> .	KCl.	
Results at 19.3°.			Results at 40.1°.		
III. 3	0.0	CdCl <sub>2</sub> ·2½H <sub>2</sub> O	133.85	0.0	CdC
59.59	6.7	" + D <sub>1-1.1</sub>	92.15	2.70	"
*26.98	11.09	D <sub>1-1.1</sub>	51.90	11.50	D <sub>1</sub>
11.61	30.04	" + D <sub>1-4</sub>	*37.91	15.21	"
1.44	34.76	D <sub>1-4</sub> +KCl	24.45	21.73	"
0.0	33.94	KCl	18.97	35.51	"
Results at 29.7°.			19.92	37.63	"
129.65	0.0	CdCl <sub>2</sub> ·2½H <sub>2</sub> O	2.98	40.45	D <sub>1-</sub>
97.62	0.70	"	0.0	40.36	]
68.23	7.08	" + D <sub>1-1.1</sub>	Results at 54.5°.		
47.12	9.89	D <sub>1-1.1</sub>	133.9	0.0	CdC
*32.67	13.06	"	102.15	2.32	"
24.26	16.10	"	*44.01	18.39	D <sub>1-1</sub>
15.99	25.97	"	26.13	43.78	"
15.47	33.58	" + D <sub>1-4</sub>	4.20	45.52	D <sub>1</sub>
2.42	37.66	D <sub>1-4</sub> +KCl	0.0	43.00	
0.0	37.21	KCl			

D<sub>1-1.1</sub> = CdCl<sub>2</sub>·KCl·H<sub>2</sub>O, D<sub>1-4</sub> = CdCl<sub>2</sub>·4KCl.

\* Shows the solubility of the double salt in water.

## **SOLUBILITY OF THE DOUBLE SALT. CdCl<sub>2</sub>·4KCl IN WATER. (Sudh**

°.	Gms. CdCl <sub>2</sub> ·4KCl per 100 gms. H <sub>2</sub> O.	Mol. Ratio in Solution.
19.3	41.65	1CdCl <sub>2</sub> : 6.37 KCl
23.6	45.35	" : 5.85 "
29.7	49.05	" : 5.34 "
40.1	57.55	" : 4.60 "
50.2	68.89	" : 4.30 "
54.5	69.91	" : 4.12 "

## **SOLUBILITY OF CADMIUM CHLORIDE IN AQUEOUS SOLUTIONS OF SODIUM AT SEVERAL TEMPERATURES AND VICE VERSA. (Sudhaus, 1914**

Gms. per 100 gms. H <sub>2</sub> O.		Solid Phase.	Gms. per 100 gms. H <sub>2</sub> O.		Solid I
CdCl <sub>2</sub> .	NaCl.		CdCl <sub>2</sub> .	NaCl.	
Results at 19.3°.			Results at 29.7° (con.).		
111.30	0.0	CdCl <sub>2</sub> ·2½H <sub>2</sub> O	*43.74	27.46	D <sub>1-2.3</sub>
116.64	7.52	" + D <sub>1-2.3</sub>	9.43	37.54	" +
85.15	12.19	D <sub>1-2.3</sub>	Results at 40.1°.		
*40.01	25.67	"	137.03	15.14	CdCl <sub>2</sub> ·H <sub>2</sub> C
5.96	36.76	" + NaCl	*48.17	29.50	D <sub>1-2.3</sub>
0.0	35.84	NaCl	13.31	38.16	" +
Results at 29.7°.			Results at 54.5°.		
132.67	9.63	CdCl <sub>2</sub> ·2½H <sub>2</sub> O + D <sub>1-2.3</sub>	140.42	19.10	CdCl <sub>2</sub> ·H <sub>2</sub> C
123.54	10.10	D <sub>1-2.3</sub>	*52.76	32.97	D <sub>1-2.3</sub>
106.16	12.92	"	22.53	39.07	" +
91.10	15.41	"	0.0	36.82	NaC

D<sub>1-2.3</sub> = CdCl<sub>2</sub>·2NaCl·3H<sub>2</sub>O.

\* Shows the solubility of the double salt in water.

## **CADMIUM CINNAMATES (C<sub>6</sub>H<sub>5</sub>CH:CH.COO)<sub>2</sub>Cd.**

100 gms. water dissolve 0.070 gm. cadmium cinnamate at 26°.	(d
100 " " " 0.56 " cadmium isocinnamate at 20°.	(M
100 " " " 0.10 " cadmium allocinnamate at 20°.	



**CADMIUM CYANIDE**  $\text{Cd}(\text{CN})_2$ .

10 gms.  $\text{H}_2\text{O}$  dissolve 1.7 gms.  $\text{Cd}(\text{CN})_2$  at  $15^\circ$ .

(Joannis, 1882.)

**CADMIUM FLUORIDE**  $\text{CdF}_2$ .

100 cc. of sat. solution in water contain 4.33 gms.  $\text{CaF}_2$  at  $25^\circ$ .

100 cc. of sat. solution in 1.08 n. HF contain 5.62 gms.  $\text{CaF}_2$  at  $25^\circ$ . (Jaeger, 1901.)

Freezing-point lowering data (solubility, see footnote, p. 1) are given for mixtures of cadmium fluoride and cadmium iodide by Ruff and Plato (1903), and for mixtures of cadmium fluoride and sodium fluoride by Puschin and Baskov, (1913).

**CADMIUM HYDROXIDE**  $\text{Cd}(\text{OH})_2$ .

## SOLUBILITY IN WATER.

1 liter of aqueous solution contains 0.0026 gm.  $\text{Cd}(\text{OH})_2$  at  $25^\circ$ .

(Bodländer, 1898.)

## SOLUBILITY IN AQUEOUS AMMONIUM HYDROXIDE SOLUTIONS.

Results at  $25^\circ$ .

(Bonsdorff, 1904.)

Normality of $\text{NH}_3$	Gms. $\text{Cd}(\text{OH})_2$ per liter.
0.5	0.274
1.0	0.707
1.8	1.516
4.6	5.609

Results at  $16-21^\circ$ .

(Euler, 1903.)

Normality of $\text{NH}_3$	Gms. $\text{Cd}(\text{OH})_2$ per liter.
0.47	0.44
0.87	1.17
0.26	0.09
0.51	0.32

**CADMIUM IODIDE**  $\text{CdI}_2$ .

## SOLUBILITY IN WATER.

(Diets, 1900; see also Kremers, 1858; Eder, 1876; Etard, 1894.)

$t^\circ$	Gms. $\text{CdI}_2$ per 100 Gms.		Mols. $\text{CdI}_2$ per 100 Mols. $\text{H}_2\text{O}$ .	$t^\circ$	Gms. $\text{CdI}_2$ per 100 Gms.		Mols. $\text{CdI}_2$ per 100 Mols. $\text{H}_2\text{O}$ .
	Solution.	Water.			Solution.	Water.	
0	44.4	79.8	3.9	30	47.3	89.7	4.43
10	45.4	83.2	4.1	40	48.4	93.8	4.6
15	45.8	84.5	4.17	50	49.35	97.4	4.8
18	46.02	85.2	4.2	75	52.65	111.2	5.4
20	46.3	86.2	4.26	100	56.08	127.6	6.3
25	46.8	87.9	4.34				

Density of saturated solution at  $18^\circ = 1.590$ .

## SOLUBILITY OF CADMIUM IODIDE IN ORGANIC SOLVENTS.

Solvent.	$t^\circ$	Gms. $\text{CdI}_2$ per 100 Gms.		Observer.
		Solution.	Solvent.	
Absolute Alcohol	15	50.5	102	(Eder.)
Ethyl Alcohol	20	42.6	74.27	(Timofeiew, 1891.)
Methyl Alcohol	20	59.0	143.7	(Timofeiew, 1891.)
Propyl Alcohol	20	28.9	40.67	(Timofeiew, 1891.)
Absolute Acetone	18	20	25*	(Naumann, 1904.)
Benzonitrile	18	...	1.63	(Naumann, 1914.)
Ethyl Acetate	18	...	1.84 †	(Naumann, 1910.)
Ethyl Ether	12°	...	0.143	(Tyrer, 1911.)
Anhy. Hydrazine	15-20	...	84 †	(Welsh and Broderson, 1915.)
Benzene	16.0		0.047	(Linebarger, 1895.)
"	35.0		0.094	"

\*  $d_{20} = .994$ .

†  $d_{18} = .9145$ .

‡ per 100 cc.



SOLUBILITY OF CADMIUM IODIDE IN METHYL ALCOHOL, ETHYL ALCOHOL, PROPYL ALCOHOL AND IN ISOPROPYL ALCOHOL AT DIFFERENT TEMPERATURES.  
(Muchin, 1913, see also Timofeiew, 1894.)

t°.	Grams CdI <sub>2</sub> per 100 Grams Sat. Solution in:			
	CH <sub>3</sub> OH.	C <sub>2</sub> H <sub>5</sub> OH.	C <sub>3</sub> H <sub>7</sub> OH.	C <sub>3</sub> H <sub>7</sub> OH(is).
0	67	33.5	16	36.9
5	...	41	22	36.9
10	68	54 (at 12.6° = tr. temp.)	28.5	37.2
20	69	53	41.5 (tr. temp.)	37.3
25	69.5	52.2	37.8	37.3
30	70	51.5	35.5	37.3
40	71	50.8	34.5	37.3
50	72.5	50	34.0	37.3

SOLUBILITY OF CADMIUM IODIDE IN ETHYL ETHER. (Linebarger, 1895.)

t°.	Mols. CdI <sub>2</sub> per 100 Mols. CdI <sub>2</sub> + (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.		Gms. CdI <sub>2</sub> per 100 gms. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	
0		0.03		0.148
15.5		0.04		0.198
20.3		0.05		0.247

SOLUBILITY OF CADMIUM IODIDE IN METHYL FORMATE, ETHYL FORMATE, PROPYL FORMATE AND IN ETHYL ACETATE AT DIFFERENT TEMPERATURES. (Muchin, 1913.)

t°.	Gms. CdI <sub>2</sub> per 100 Gms. Sat. Solution in:			
	HCOOCH <sub>3</sub> .	HCOOC <sub>2</sub> H <sub>5</sub> .	HCOOC <sub>3</sub> H <sub>7</sub> .	CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub> .
0	0.84	1.16	2.37	4.73(?)
13.0	0.75	1.05	2.07	1.67
26.0	0.66	0.77	1.53	2.02

SOLUBILITY OF CADMIUM IODIDE IN ANILINE, PYRIDINE AND IN QUINOLINE AT DIFFERENT TEMPERATURES. (Muchin, 1913.)

t°.	Gms. CdI <sub>2</sub> per 100 Gms. Sat. Solution in:		
	C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> .	C <sub>5</sub> H <sub>5</sub> N.	C <sub>8</sub> H <sub>7</sub> N.
40	1.7	...	...
50	2.3	0.1	...
60	3.1	0.5	2
70	4	1.7	3.5
80	5.1	4.8	5
90	6.4	13.4	6.7
100	8.4	30	8.3

SOLUBILITY OF CADMIUM IODIDE IN MIXTURES OF SOLVENTS AT DIFFERENT TEMPERATURES. (Muchin, 1913.)

Composition of Solvent in Mols.	Wt. per cent Alcohol in Solvent.	Gms. CdI <sub>2</sub> per 100 Gms. Sat. Solution at:		
		0°.	16.8°.	36.3°.
1CH <sub>3</sub> OH + 2CHCl <sub>3</sub>	11.8	11.0	10.4	9.3
1CH <sub>3</sub> OH + 1CHCl <sub>3</sub>	21.1	22.4	22.3	20.6
1C <sub>2</sub> H <sub>5</sub> OH + 2CHCl <sub>3</sub>	16.2	7.5	7.1	6.6
1C <sub>2</sub> H <sub>5</sub> OH + 1CHCl <sub>3</sub>	27.8	13.9	14.3	13.6
2C <sub>2</sub> H <sub>5</sub> OH + 1CHCl <sub>3</sub>	43.5	25.2	24.1	...
x C <sub>2</sub> H <sub>5</sub> OH + y CHCl <sub>3</sub>	60.3	34.4	...	...
" "	91.5	45.4	...	...
1C <sub>2</sub> H <sub>5</sub> OH + 2C <sub>6</sub> H <sub>6</sub>	22.8	17.6	16.3 (16.3°)	15.2 (31.1°)
1C <sub>2</sub> H <sub>5</sub> OH + 1C <sub>6</sub> H <sub>6</sub>	37.1	26.1	26.0 (15.7°)	26.0 "
2C <sub>2</sub> H <sub>5</sub> OH + 1C <sub>6</sub> H <sub>6</sub>	54.1	33.5	35.3 (15°)	...
x C <sub>2</sub> H <sub>5</sub> OH + y C <sub>6</sub> H <sub>6</sub>	9.8	6.5	...	...



## SOLUBILITY OF CADMIUM IODIDE IN MIXTURES OF SOLVENTS.

(Muehlin, 1913.)

for a mixed solvent composed of:

Sol. Pyridine + One Mol. Chloroform.			One Mol. Pyridine + One Mol. Benzene.		
Gms. CdI <sub>2</sub> per 100 Gms. Sat. Sol.	t°.	Gms. CdI <sub>2</sub> per 100 Gms. Sat. Sol.	Gms. CdI <sub>2</sub> per 100 Gms. Sat. Sol.	t°.	Gms. CdI <sub>2</sub> per 100 Gms. Sat. Sol.
1.27	63	6.3	57.9	1.77	72.5
1.72	64	8.3	60	2.2	74.0
2.3	64.5	12.35	65	4.2	76
3.0	64	14.8	70	8.1	80
4.0	62	22.0	71	11.5	85
5.6	61.15	24.67	71.5	15.0	90.4

## SOLUBILITY OF CADMIUM IODIDE IN ETHYL ETHER CONTAINING WATER AT 12°.

(Tyrer, 1911.)

as H <sub>2</sub> O per 100 gms. ether + H <sub>2</sub> O →	0.0	0.10	0.30	0.50	0.70	0.90	1.00	1.10	1.14 sat.
as CdI <sub>2</sub> per 100 gms. solvent →	0.143	0.78	2.07	3.36	4.77	6.46	7.30	8.27	8.68

## DISTRIBUTION OF CADMIUM IODIDE AT 30° BETWEEN:

(Dahr and Datter, 1913.)

Water and Amyl Alcohol.		Water and Ethyl Ether.	
Gms. per 100 cc. (c). Alcohol Layer (c).	$\frac{c}{c'}$	Gms. per 100 cc. H <sub>2</sub> O Layer (c).	$\frac{c}{c'}$
43	1.11	37.18	4.43
25.86	1.13	30.03	4.54
12.55	1.15	15.38	4.97
8.94	1.20	12.60	5.29
4.94	1.33	9.89	5.40
1.54	1.55	7.68	5.52
1.10	1.76	4.03	5.60
0.94	1.87	3.10	6.03

point data (solubility, see footnote, p. 1) are given for the following

Cadmium Iodide	+ Cuprous Iodide	(Herrmann, 1911.)
"	+ Mercuric Iodide	(Sandonnini, 1914.)
"	+ Potassium Iodide	(Brand, 1912.)
"	+ Sodium Iodide	"

## AMMONIUM IODIDES (Mono and Di).

## SOLUBILITY OF EACH SEPARATELY IN WATER, ETC.

(Rimbach, 1905; Eder, 1876.)

## Cd. Mono Ammonium Iodide.

t°.	Gms. CdI <sub>2</sub> .NH <sub>4</sub> I per 100 Gms.	
	Solution.	Solvent.
15	52.6	111
15	53	113
15	29.4	41.7

## Cd. Diammonium Iodide.

t°.	Gms. CdI <sub>2</sub> .2NH <sub>4</sub> I per 100 Gms.	
	Solution.	Solvent.
14.5	85.97	611.6
15	59	143
15	10	11



# **CADMIUM IODIDES**

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## **CADMIUM POTASSIUM IODIDES, Mono = $\text{CdI}_2 \cdot \text{KI} \cdot \text{H}_2\text{O}$ ,**

Di =  $\text{CdI}_2 \cdot 2\text{KI} \cdot 2\text{H}_2\text{O}$ .

## **CADMIUM DISODIUM IODIDE $\text{CdI}_2 \cdot 2\text{NaI} \cdot 6\text{H}_2\text{O}$ .**

SOLUBILITY OF EACH SEPARATELY IN WATER, ETC., AT 15°.

(Eder.)

Solvent.	Gms. $\text{CdI}_2 \cdot \text{KI}$ per 100 Gms.		Gms. $\text{CdI}_2 \cdot 2\text{KI}$ per 100 Gms.		Gms. $\text{CdI}_2 \cdot 2\text{NaI}$ per 100 Gms.	
	Solution.	Solvent.	Solution.	Solvent.	Solution.	Solvent.
Water	51.5	106	57.8	137	61.3	158.8
Abs. Alcohol	...	...	41.7	71	53.7	116.2
Abs. Ether	...	...	3.9	4.1	9.0	9.9

## **CADMIUM NITRATE $\text{Cd}(\text{NO}_3)_2$ .**

SOLUBILITY IN WATER.

(Funk — Wiss. Abh. p. t. Reichanstalt 3 440, '00.)

t°.	Gms. $\text{Cd}(\text{NO}_3)_2$ per 100 Gms.		Mols. $\text{Cd}(\text{NO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
	Solution.	Water.		
-13	37.37	59.67	4.55	$\text{Cd}(\text{NO}_3)_2 \cdot 9\text{H}_2\text{O}$
-1	47.33	89.86	6.85	"
+1	52.73	111.5	8.50	"
0	52.37	109.7	8.37	$\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$
+18	55.9	126.8	9.61	"
30	58.4	140.4	10.7	"
40	61.42	159.2	12.1	"
59.5	76.54	326.3	25.0	"

Density of saturated solution at 18° = 1.776.

The eutectic of the system  $\text{Cd}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O} + \text{Cd}(\text{NO}_3)_2$  is at 44.8° and has the composition  $\text{Cd}(\text{NO}_3)_2 \cdot 2.65\text{H}_2\text{O}$ . (Vasilev, 1910.)

## **CADMIUM OXALATE $\text{CdC}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$ .**

1 liter of sat. aqueous solution contains 0.033 gm.  $\text{CdC}_2\text{O}_4$  at 18°. (Kohlrausch, 1908.)

## **CADMIUM SILICATE $\text{CdSiO}_3$ .**

Fusion-point data are given for  $\text{CdSiO}_3 + \text{ZnSiO}_3$ .

(van Klooster, 1910-11.)

## **CADMIUM SULPHATE $\text{CdSO}_4$ .**

SOLUBILITY IN WATER.

(Mylius and Funk — W. Abh. p. t. Reichanstalt 3, 444, '00; see also Kohnstamm and Cohn — Wied Ann. 65, 344, '98; Steinwehr — Ann. der Phys. (Drude) [4] 9, 1050, '02; Etard — Ann. chim. phys [7] 2, 536, '94.)

t°.	Gms. $\text{CdSO}_4$ per 100 Gms.		Solid Phase.	t°.	Gms. $\text{CdSO}_4$ per 100 Gms.		Solid Phase.
	Solution.	Water.			Solution.	Water.	
-17	44.5	80.2	$\text{CdSO}_4 \cdot 7\text{H}_2\text{O}$	40	43.99	78.54	$\text{CdSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ .
-10	46.1	85.5	"	60	44.99	83.68	"
-5	48.5	94.2	"	73.5	46.6	87.28	"
-18	43.35	76.52	$\text{CdSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$	74.5	46.7	87.62	$\text{CdSO}_4 \cdot \text{H}_2\text{O}$
-10	43.27	76.28	"	77	42.2	73.02	"
0	43.01	76.48	"	85	39.6	65.57	"
+10	43.18	76.00	"	90	38.7	63.13	"
20	43.37	76.60	"	100	37.8	60.77	"

For results at high pressures, see Cohen (1909).



**SOLUBILITY OF CADMIUM SULPHATE IN AQUEOUS SOLUTIONS OF SULPHURIC ACID AT 0°.**

(Engel—Compt. rend. 104, 507, '87.)

Equivalents per 10 Gms. H <sub>2</sub> O.		Density of Solutions.	Grams per 100 Grams H <sub>2</sub> O.	
H <sub>2</sub> SO <sub>4</sub> .	CdSO <sub>4</sub> .		H <sub>2</sub> SO <sub>4</sub> .	CdSO <sub>4</sub> .
0.	71.6	1.609	0.00	74.61
3.87	70.9	1.591	1.90	73.87
12.6	62.4	1.545	6.18	65.03
28.1	50.6	1.476	13.78	52.73
43.3	40.8	1.435	21.23	42.52
47.6	37.0	1.421	23.34	38.56
53.8	32.7	1.407	26.38	34.07
71.5	23.0	1.379	35.06	23.96

100 gms. 95% formic acid dissolve 0.06 gm. CdSO<sub>4</sub> at 18.5°. (Aschan, 1913.)

Freezing-point data (solubility, see footnote, p. 1) are given for mixtures of CdSO<sub>4</sub> + Li<sub>2</sub>SO<sub>4</sub>, CdSO<sub>4</sub> + K<sub>2</sub>SO<sub>4</sub> and CdSO<sub>4</sub> + Na<sub>2</sub>SO<sub>4</sub> by Calcagni and Marotta (1913).

**SOLUBILITY OF MIXED CRYSTALS OF CADMIUM SULPHATE AND FERROUS SULPHATE IN WATER AT 25°.**

(Stortenbecker—Z. physik. Chem. 34, 109, '00.)

Composition of Solution.					Mol. per cent Cd in Crystals of Solid Phase.
Gms. per 100 Gms. H <sub>2</sub> O.		Mols. per 100 Mols. H <sub>2</sub> O.		Mol. % Cd. in Sol.	
CdSO <sub>4</sub> .	FeSO <sub>4</sub> .	Cd.	Fe.		
Crystals with 2½ Mols. H <sub>2</sub> O.					
76.02	0.0	6.57	0.0	100	100
57.61	10.63	4.98	1.26	79.8	99.0
Crystals with 7 Mols. H <sub>2</sub> O.					
57.61	10.63	4.98	1.26	79.8	36.6
...	...	...	...	78.5	34.6
...	...	...	...	44.6	11.1
...	...	...	...	24.4	4.8
0.0	26.69	0.0	3.165	0.0	0.0

**CADMIUM POTASSIUM SULFATE CdK<sub>2</sub>(SO<sub>4</sub>)<sub>2</sub>.**

**SOLUBILITY IN WATER.**

(Wyrouboff, 1901.)

t°.	G. CdK <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> per 100 Gms. H <sub>2</sub> O.	Solid Phase.	t°.	G. CdK <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> per 100 Gms. H <sub>2</sub> O.	Solid Phase.
16	42.89	CdK <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·2H <sub>2</sub> O	26	42.50	CdK <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·1½H <sub>2</sub> O
31	46.82	"	31	42.80	"
40	47.40	"	40	43.45	"
			64	44.90	"



**CADMIUM SODIUM SULFATE 180**

**CADMIUM SODIUM SULFATE**  $\text{CdNa}_2(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$ .

SOLUBILITY IN WATER, ALSO WITH THE ADDITION OF CADMIUM SULPHATE AND OF SODIUM SULPHATE.

(Koppel, Gumpert — Z. physik. Chem. 52, 413, '05.)

t°.	Gms. per 100 Gms. Solution.		Gms. per 100 Gms. $\text{H}_2\text{O}$ .		Mols. per 100 Mols. $\text{H}_2\text{O}$ .		Solid Phase.
	$\text{CdSO}_4$ .	$\text{Na}_2\text{SO}_4$ .	$\text{CdSO}_4$ .	$\text{Na}_2\text{SO}_4$ .	$\text{CdSO}_4$ .	$\text{Na}_2\text{SO}_4$ .	
24	22.25	15.07	35.49	24.04	3.07	3.05	$\text{CdNa}_2(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$
30	22.55	15.29	36.28	24.60	3.14	3.12	
40	22.89	15.65	37.24	25.45	3.22	3.28	
0	40.32	4.85	73.54	8.85	6.36	1.12	$\text{CdNa}_2(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$ + $\text{CdSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$
10	39.91	5.24	72.77	9.55	6.30	1.21	
20	40.26	5.16	73.81	9.45	6.39	1.20	
40	39.89	7.18	75.38	13.56	6.52	1.72	
-14.8	40.18	4.60	72.68	8.32	6.29	1.05	$\text{CdNa}_2(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$ + $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
0	37.30	6.53	66.32	11.62	5.74	1.47	
10	32.53	8.69	55.34	14.78	4.79	1.84	
20	22.69	14.71	36.25	23.52	3.14	2.98	
25	16.33	19.82	25.60	31.06	2.21	3.94	$\text{CdNa}_2(\text{SO}_4)_2 \cdot 2\text{H}_2\text{O}$ + $\text{Na}_2\text{SO}_4$
30	9.21	27.80	14.62	44.14	1.26	4.59	
35	8.26	29.35	13.26	47.06	1.15	5.96	
40	9.98	28.27	16.24	46.27	1.41	5.86	

**CADMIUM SULFIDE**  $\text{CdS}$ .

1000 cc.  $\text{H}_2\text{O}$  dissolves  $9 \times 10^{-4}$  gms.  $\text{CdS}$  at  $18^\circ$ .

(Weigel, 1906.)

**CAESIUM ALUMS**

SOLUBILITY OF CAESIUM CHROMIUM ALUM, CAESIUM IRON ALUM, CAESIUM INDIUM ALUM, AND OF CAESIUM VANADIUM ALUM IN WATER.

(Locke — Am. Ch. J. 27, 174, '01.)

Formula of Alum.	t°.	Gms. per 100 cc. $\text{H}_2\text{O}$ .		Gram Mols. Salt per 100 cc. $\text{H}_2\text{O}$ .
		Anhydrous Salt.	Hydrated Salt.	
$\text{Cs}_2\text{Cr}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$	25	0.57	0.94	0.00151
"	30	0.96	1.52	0.0025
"	35	1.206	1.91	0.0032
"	40	1.53	2.43	0.00405
$\text{Cs}_2\text{Fe}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$	25	1.71	2.72	0.0045
"	30	2.52	4.01	0.0066
"	35	3.75	6.01	0.0099
"	40	6.04	9.80	0.0156
$\text{Cs}_2\text{In}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$	25	7.57	11.73	0.0172
$\text{Cs}_2\text{V}_2(\text{SO}_4)_4 \cdot 24\text{H}_2\text{O}$	25	0.771	1.31	0.00204

See also Alums, p. 32.



**CAESIUM CHLORAUATE**  $\text{CsAuCl}_4$ .**SOLUBILITY IN WATER.**  
(Rosenblatt, 1886.)

t°.	Gms. $\text{CsAuCl}_4$ per 100 Gms. Solution.	t°.	Gms. $\text{CsAuCl}_4$ per 100 Gms. Solution.	t°.	Gms. $\text{CsAuCl}_4$ per 100 Gms. Solution.
10	0.5	40	3.2	80	16.3
20	0.8	50	5.4	90	21.7
30	1.7	60	8.2	100	27.5
		70	12.0		

**CAESIUM FLUOBORIDE**  $\text{CsBF}_4$ .

100 grams water dissolve 0.92 gram  $\text{CsBF}_4$  at 20°, and 0.04 gram at 100°.  
(Godefroy, 1876.)

**CAESIUM BROMIDE**  $\text{CsBr}$ .**SOLUBILITY OF CAESIUM AND LEAD BROMIDES AND THEIR DOUBLE SALTS  
IN WATER AT 25°.**  
(Foote, 1907.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
CsBr.	PbBr <sub>2</sub> .		CsBr.	PbBr <sub>2</sub> .	
0.24	0.33	$\text{PbBr}_2 + \text{CsPb}_2\text{Br}_5$	33.65	trace	$\text{CsPbBr}_3$
0.33	0.36	"	36.7	"	" + $\text{Cs}_4\text{PbBr}_8$
12.83	trace	$\text{CsPb}_2\text{Br}_5$	46.4	"	$\text{Cs}_4\text{PbBr}_8$
17.24	"	"	51.15	"	"
17.68	"	" + $\text{CsPbBr}_3$	54.4	"	" + $\text{CsBr}$
18.58	"	$\text{CsPbBr}_3$	55.23	0	$\text{CsBr}$

**CAESIUM Mercuric BROMIDE**  $\text{CsBr} \cdot 2\text{HgBr}_2$ .

100 grams saturated aqueous solution contain 0.807 gram  $\text{CsBr} \cdot 2\text{HgBr}_2$  at 16°.  
(Wells, 1892.)

**CAESIUM CARBONATE**  $\text{Cs}_2\text{CO}_3$ .

100 grams absolute alcohol dissolve 11.1 grams  $\text{Cs}_2\text{CO}_3$  at 19°, and 20.1 grams at b. pt.  
(Bunsen.)

**CAESIUM BicARBONATE**  $\text{CsHCO}_3$ .

100 grams sat. solution in  $\text{H}_2\text{O}$  contain 67.8 grams  $\text{CsHCO}_3$  at about 20°.  
(de Forcaud, 1909.)

**CAESIUM CHLORATE**  $\text{CsClO}_3$ , **CAESIUM PerCHLORATE**  $\text{CsClO}_4$ .**SOLUBILITY OF EACH IN WATER.**  
(Calzolari, 1912; see also Carlson, 1910.)

Results for $\text{CsClO}_3$ .				Results for $\text{CsClO}_4$ .			
t°.	Gms. $\text{CsClO}_3$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{CsClO}_3$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{CsClO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{CsClO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .
0	2.46	50	19.4	0	0.8	50	5.4
10	3.8	60	26.2	10	1.0	60	7.3
20	6.2	70	34.7	20	1.6	70	9.8
25	7.6	80	45.0	25	2.0 ( $d=1.01$ )	80	14.4 ( $d=1.084$ )
30	9.5	90	58.0	30	2.6	90	20.5
40	13.8	100	79.0	40	4.0	100	30.0



Freezing-point lowering data (solubilities, see footnote, p. 1) are given for the following mixtures of caesium chloride and other salts.

Mixture.		Authority.
Caesium Chloride	+ Cuprous Chloride	(Sandonnini and Scarpa, 1912; Sandonnini, 1914.)
"	+ Silver Chloride	" "
"	+ Thallium Chloride	" "
"	+ Lithium Chloride	(Korring, 1915; Richards and Meldrum, 1917.)
"	+ " " + NaCl	(Richards and Meldrum, 1917.)
"	+ Potassium Chloride	(Zemcszany and Rambach, 1910.)
"	+ Rubidium "	" "
"	+ Sodium "	" "

#### CAESIUM CHROMATES, $\text{Cs}_2\text{CrO}_4$ , $\text{Cs}_2\text{Cr}_2\text{O}_7$ , etc.

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
Cs <sub>2</sub> O.	CrO <sub>3</sub> .		Cs <sub>2</sub> O.	CrO <sub>3</sub> .	
70.63	0.0	$\text{CsOH} \cdot n\text{H}_2\text{O}$	0.169	21.21	$\text{Cs}_2\text{Cr}_2\text{O}_7$
69.22	0.119	" + $\text{Cs}_2\text{CrO}_4$	0.096	25.59	"
36.06	1.883	$\text{Cs}_2\text{CrO}_4$	1.89	36.19	"
31.00	7.523	"	2.79	41.68	"
31.68	9.652	"	3.29	44.23	"
35.80	13.08	"	$\pm 3.13$	$\pm 44.45$	" + $\text{Cs}_2\text{Cr}_4\text{O}_{18}$
31.05	10.79	$\text{Cs}_2\text{Cr}_2\text{O}_7$	2.96	44.66	$\text{Cs}_2\text{Cr}_4\text{O}_{18}$
24.05	8.98	"	3.40	46.03	"
3.04	2.16	"	3.94	56.77	"
1.61	4.57	" + $\text{Cs}_2\text{Cr}_2\text{O}_7$	4.35	62.70	" + $\text{CrO}_3$
1.18	7.95	$\text{Cs}_2\text{Cr}_2\text{O}_7$	2.33	62.50	$\text{CrO}_3$
0.586	15.05	"	0	62.28	"

#### CAESIUM FLUORIDE $\text{CsF} \cdot 1\frac{1}{2}\text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 366.5 gms.  $\text{CsF}$  at  $18^\circ$ , solid phase  $\text{CsF} \cdot 1\frac{1}{2}\text{H}_2\text{O}$ .  
(de Forcrand, 1911.)

#### CAESIUM HYDROXIDE $\text{CsOH}$ .

100 gms. sat. solution in  $\text{H}_2\text{O}$  contain 79.41 gms.  $\text{CsOH}$  at  $15^\circ$  (de Forcrand, 1909a); for  $30^\circ$ , see above.

#### CAESIUM IODATE $\text{CsIO}_4$ .

100 parts  $\text{H}_2\text{O}$  dissolve 2.6 parts  $\text{CsIO}_3$  at  $24^\circ$ , and 2.5 parts  $2\text{CsIO}_3 \cdot \text{I}_2\text{O}_5$  at  $21^\circ$ .  
(Wheeler, 1892; Barker, 1908.)

#### CAESIUM Per IODATE $\text{CsIO}_4$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 2.15 gms.  $\text{CsIO}_4$  at  $15^\circ$ ,  $d_{15}$  sat. solution = 1.0166. (Barker, 1908.)

#### CAESIUM IODIDES $\text{CsI}$ , $\text{CsI}_3$ , etc.

##### SOLUBILITY IN WATER AT $25^\circ$ .

(Foote and Chalker, 1908.)

Gms. per 100 Gms. Sat. Solution.		Empirical Comp. of Residue.	Present in Residue.
CsI.	I.		
7.72	1.18	$\text{CsI}_{3.29}$	$\text{CsI}_3$ and $\text{CsI}_5$
7.69	1.19	$\text{CsI}_{3.98}$	" "
2.40	1.23	$\text{CsI}_{5.76}$	$\text{CsI}_5$ and I
2.35	1.23	$\text{CsI}_{7.48}$	" "
2.39	1.25	$\text{CsI}_{19.3}$	" "



**CAESIUM IODIDE** CsI.**SOLUBILITY OF MIXTURES OF CAESIUM IODIDE AND IODINE IN WATER.**

(Foote — Am. Ch. J. 29, 210, '03.)

t°.	Gms. per 100 Gms. Solution.		t°.	Gms. per 100 Gms. Solution.		Solid Phase at both Temps.
	CsI.	I.		CsI.	I.	
-4	27.68	0.0	35.6	51.48	0.0	CsI
-4	27.52	0.09	35.6	51.66	0.71	CsI and CsI <sub>2</sub>
-4	3.18	0.31	35.6	10.72	1.78	CsI <sub>2</sub> and CsI <sub>3</sub>
-0.2	0.85	0.34	35.6	3.74	1.60	CsI <sub>2</sub> and I

t°.	Gms. per 100 Gms. Solution.		In Separated Heavy Solution Gms. per 100 Gms. Solution.		Solid Phase.
	CsI.	I.	CsI.	I.	
52.2	16.75	4.52	...	...	CsI <sub>2</sub> and CsI <sub>3</sub>
52.2	6.69	3.36	...	...	CsI <sub>2</sub> and I
52.2	6.72	3.32	22.94	73.72	CsI <sub>2</sub>
52.2	6.65	3.45	22.80	74.63	I
73	26.98	15.07	...	...	CsI <sub>2</sub> and CsI <sub>3</sub>
73	16.66	10.50	27.56	68.40	CsI <sub>2</sub>
73	6.27	4.08	17.68	80.02	I

**CAESIUM (Tri) IODIDE** CsI<sub>3</sub>.

100 cc. saturated aqueous caesium iodide (about 17 per cent CsI) solution contain 0.97 gram CsI<sub>3</sub> at 20°, density of solution = 1.154.

(Wells — Am. J. Sci. [3] 44, 221, '02.)

**CAESIUM NITRATE** CsNO<sub>3</sub>.**SOLUBILITY IN WATER.**

(Berkeley — Trans. Roy. Soc. (Lond.) 203 A, 213, '04.)

t°.	Gms. CsNO <sub>3</sub> per 100 Gms. Solution.		G. Mols. CsNO <sub>3</sub> per Liter.	t°.	Gms. CsNO <sub>3</sub> per 100 Gms. Solution.		G. Mols. CsNO <sub>3</sub> per Liter.
	Solution.	Water.			Solution.	Water.	
0	8.54	9.33	0.476	60	45.6	83.8	3.41
10	12.97	14.9	0.725	70	51.7	107.0	4.10
20	18.7	23.0	1.11	80	57.3	134.0	4.81
30	25.3	33.9	1.58	90	62.0	163.0	5.50
40	32.1	47.2	2.12	100	66.3	197.0	6.19
50	39.2	64.4	2.73	106.2	68.8	220.3	6.58

**THE ICE CURVES FOR MIXTURES OF CAESIUM NITRATE AND WATER, DETERMINED BY THE SYNTHETIC METHOD.**

(Jones, 1908.)

Solubility curve.			Supersolubility curve.		
t° of Crystallization.	Gms. CsNO <sub>3</sub> per 100 Gms. H <sub>2</sub> O.	Solid Phase.	t° of Crystallization.	Gms. CsNO <sub>3</sub> per 100 Gms. H <sub>2</sub> O.	Solid Phase.
-0.3	0.21	Ice	-1.2	0.21	Ice
-0.4	1.28	"	-2.5	1.28	"
-1.2	6.01	"	-3.0	3.99	"
-1.3	8.0	"	-3.2	6.01	"
-1.4 (Eutec.)	...	"	-3.2	8	"

The eutectic is given as -1.254° and 8.51 gms. CsNO<sub>3</sub> per 100 gms. H<sub>2</sub>O, by Washburn and MacInnes (1911).



**CAESIUM OXALATE**  $\text{Cs}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$ .**SOLUBILITY OF MIXTURES OF CAESIUM OXALATE AND OXALIC ACID IN WATER AT 25°.**

(Foote and Andrew, 1905.)

Varying amounts of the two substances were dissolved in hot water and the solutions allowed to cool in a thermostat held at 25°.

Gms. per 100 Gms. Solution.		G. Mols. per 100 G. Mols. $\text{H}_2\text{O}$ .		Solid Phase.
$\text{H}_2\text{C}_2\text{O}_4$ .	$\text{Cs}_2\text{C}_2\text{O}_4$ .	$\text{H}_2\text{C}_2\text{O}_4$ .	$\text{Cs}_2\text{C}_2\text{O}_4$ .	
10.20	...	2.274	...	$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$
10.29	0.61	2.314	0.035	$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} + \text{H}_3\text{Cs}(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$
7.90	9.92	1.924	0.614	Double Salt.
4.11	25.12	1.162	1.81	$\text{H}_3\text{Cs}(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$
4.32	27.55	1.279	2.06	$\text{H}_3\text{Cs}(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O} + \text{H}_4\text{Cs}_2(\text{C}_2\text{O}_4)_3$
4.27	28.30	1.267	2.14	Double Salt.
4.40	35.90	1.476	3.07	$\text{H}_4\text{Cs}_2(\text{C}_2\text{O}_4)_3$
4.82	40.10	1.752	3.71	$\text{H}_4\text{Cs}_2(\text{C}_2\text{O}_4)_3 + \text{HCsC}_2\text{O}_4$
4.45	42.32	1.672	4.05	Double Salt.
3.05	48.80	1.268	5.16	$\text{HCsC}_2\text{O}_4$
1.04	68.69	0.688	11.56	
0.91	71.24	0.648	13.06	$\text{HCsC}_2\text{O}_4 + \text{H}_6\text{Cs}_3(\text{C}_2\text{O}_4)_7$
0.77	73.45	0.598	14.51	Double Salt.
0.75	74.04	0.596	14.96	$\text{H}_6\text{Cs}_3(\text{C}_2\text{O}_4)_7$
0.74	75.20	0.625	15.93	$\text{H}_6\text{Cs}_3(\text{C}_2\text{O}_4)_7 + \text{Cs}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$
0.0	75.82	0.0	15.97	$\text{Cs}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$

**CAESIUM Telluracid OXALATE**  $\text{Cs}_2[\text{H}_6\text{TeO}_6 \cdot \text{C}_2\text{O}_4]$ .100 gms.  $\text{H}_2\text{O}$  dissolve 6.42 gms.  $\text{Cs}_2[\text{H}_6\text{TeO}_6 \cdot \text{C}_2\text{O}_4]$  at 0°, 12.39 gms. at 20°, 15.08 gms. at 30°, 19.78 gms. at 40° and 27.66 gms. at 50°.

(Rosenheim and Weinheber, 1910-11.)

**CAESIUM PERMANGANATE**  $\text{CsMnO}_4$ .100 cc. sat. aqueous solution contain 0.097 gm.  $\text{CsMnO}_4$  at 1°, 0.23 gm. at 19°, and 1.25 gms. at 59°.

(Patterson — J. Am. Chem. Soc. 28, 1735, '06.)

**CAESIUM SELENATE**  $\text{Cs}_2\text{SeO}_4$ .100 grams  $\text{H}_2\text{O}$  dissolve 245 grams  $\text{Cs}_2\text{SeO}_4$  at 12°.

(Tutton — J. Chem. Soc. 71, 850, '97.)

**CAESIUM SULPHATE**  $\text{Cs}_2\text{SO}_4$ .**SOLUBILITY IN WATER.**

(Berkeley — Trans. Roy. Soc. (Lond.) 203 A, 210, '04.)

t°.	Gms. $\text{Cs}_2\text{SO}_4$ per 100 Gms.		G. Mols. $\text{Cs}_2\text{SO}_4$ per Liter.	t°.	Gms. $\text{Cs}_2\text{SO}_4$ per 100 Gms.		G. Mols. $\text{Cs}_2\text{SO}_4$ per Liter.
	Solution.	Water.			Solution.	Water.	
0	62.6	167.1	3.42	60	66.7	199.9	3.78
10	63.4	173.1	3.49	70	67.2	205.0	3.83
20	64.1	178.7	3.56	80	67.8	210.3	3.88
30	64.8	184.1	3.62	90	68.3	214.9	3.92
40	65.5	189.9	3.68	100	68.8	220.3	3.97
50	66.1	194.9	3.73	108.6	69.2	224.5	4.00



## CAESIUM DOUBLE SULFATES 186

### SOLUBILITY OF CAESIUM DOUBLE SULPHATES IN WATER AT 25°.

(Locke — Am. Ch. J. 27, 459, '01.)

Name.	Formula.	Gms. Anhydrous Salt per 100 Gms.		Gm. Moh. Salt per 100 Gm. H <sub>2</sub> O.
		Solution.	Water.	
Caesium Cadmium Sulphate	C <sub>2</sub> Cd(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	58.16	139.9	0.2455
Caesium Cobalt Sulphate	C <sub>2</sub> Co(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	29.52	41.9	0.081
Caesium Copper Sulphate	C <sub>2</sub> Cu(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	31.49	46.0	0.0882
Caesium Iron Sulphate	C <sub>2</sub> Fe(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	50.29	101.1	0.1967
Caesium Magnesium Sulphate	C <sub>2</sub> Mg(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	34.77	53.3	0.1106
Caesium Manganese Sulphate	C <sub>2</sub> Mn(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	44.58	80.4	0.157
Caesium Nickel Sulphate	C <sub>2</sub> Ni(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	20.37	25.6	0.0495
Caesium Zinc Sulphate	C <sub>2</sub> Zn(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	27.87	38.6	0.0738

### SOLUBILITY OF CAESIUM SODIUM SULFATES IN WATER AT 25°.

(Foote, 1911.)

Gms. per 100 Gms. Sat. Solution.		Per cent CaSO <sub>4</sub> in Residue.	Empirical Composition of Residue.
Cs <sub>2</sub> SO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .		
54.65	11.44	89.98	1Na <sub>2</sub> SO <sub>4</sub> ·3.53Cs <sub>2</sub> SO <sub>4</sub>
54.58	11.63	78.22	1Na <sub>2</sub> SO <sub>4</sub> ·1.41Cs <sub>2</sub> SO <sub>4</sub>
54.81	11.25	34.67	4.8Na <sub>2</sub> SO <sub>4</sub> ·1Cs <sub>2</sub> SO <sub>4</sub>

The author's solubility method for determination of the formation and composition of double salts is described in the paper containing the above results.

### CAESIUM DihydroxyTARTRATE C<sub>2</sub>C<sub>4</sub>H<sub>4</sub>O<sub>6</sub>·2H<sub>2</sub>O.

100 gms. H<sub>2</sub>O dissolve 22.5 gms. C<sub>2</sub>C<sub>4</sub>H<sub>4</sub>O<sub>6</sub>·2H<sub>2</sub>O at 0°.

(Fenton, 1898.)

### CAFFEINE C<sub>8</sub>H<sub>8</sub>(CH<sub>3</sub>)<sub>2</sub>N<sub>4</sub>O<sub>2</sub>·H<sub>2</sub>O.

#### SOLUBILITY IN WATER.

(Average curve from results of Zalai, 1910; Pellini, 1910, and U.S.P., 8th Ed.)

t°.	Gms. C <sub>8</sub> H <sub>8</sub> (CH <sub>3</sub> ) <sub>2</sub> N <sub>4</sub> O <sub>2</sub> per 100 Gms. H <sub>2</sub> O.	t°.	Gms. C <sub>8</sub> H <sub>8</sub> (CH <sub>3</sub> ) <sub>2</sub> N <sub>4</sub> O <sub>2</sub> per 100 Gms. H <sub>2</sub> O.
0	0.6	40	4.64
15	1.0	50	6.75
20	1.46	60	9.7
25	2.13	70	13.5
30	2.8	80	19.23

#### SOLUBILITY OF CAFFEINE IN ORGANIC SOLVENTS.

Solvent.	t°.	Gms. C <sub>8</sub> H <sub>8</sub> (CH <sub>3</sub> ) <sub>2</sub> N <sub>4</sub> O <sub>2</sub> per 100 Gms. Solvent.	Solvent.	t°.	Gms. C <sub>8</sub> H <sub>8</sub> (CH <sub>3</sub> ) <sub>2</sub> N <sub>4</sub> O <sub>2</sub> per 100 Gms. Solvent.
Ethyl Alcohol	25	1.32 (2)	Carbon Tetra-	18	0.09 (4)
" "	25	1.88 (1)	chloride	20	0.26 (6)
" "	60	5.85 (1)	"	b.pt.	0.70 (4)
Methyl "	25	1.14 (2)	Chloroform	17	12.9 (5)
Amyl "	25	0.50 (3) (d <sub>20</sub> =0.810)	"	25	12.3 (1)
Amyl Acetate	30.5	0.72 (3) (d <sub>20</sub> =0.862)	"	25	11.92 (2)
Acetic Acid (99.5%)	21.5	2.6 (3)	"	b.pt.	15.63 (4)
Acetone	30.5	2.32 (3) (d <sub>20</sub> =0.832)	Ether	18	0.12 (4)
Aniline	30.5	20.4 (3) (d <sub>20</sub> =1.080)	"	25	0.27 (1)
Benzaldehyde	30.5	13.1 (3) (d <sub>20</sub> =1.087)	"	b.pt.	0.30 (4)
Benzene	18.0	0.91 (4)	Trichlorethylene	15	0.76 (7)
"	25.0	1.16 (2)	Dichlorethylene	15	1.82 (7)
"	30.5	1.23 (3) (d <sub>20</sub> =0.875)	Pyridine	20-25	34.39 (8)
"	b.pt.	5.29 (4)	50% Aq. Pyridine	"	11.12 (8)
Carbon Disulfide	17	0.06 (5)	Toluene	25	0.58 (3) (d <sub>20</sub> =0.861)
			Xylene	32.5	1.13 (3) (d <sub>20</sub> =0.847)

(1) = U. S. P.; (2) = Schaefer, 1913; (3) = Seidell, 1907; (4) = Göckel, 1898; (5) = Commaille, 1875; (6) = Gori, 1913; (7) = Wester and Bruins (1914); (8) = Dehn, 1917.

Data for the solubility of caffeine in mixtures of alcohol and chloroform and alcohol and benzene are given by Schaefer (1913).



**SOLUBILITY OF CAFFEINE IN AQUEOUS SOLUTIONS OF SODIUM BENZOATE AND VICE VERSA.** (Pellini, 1910.)

Results at 25°.			Results at 40°.		
Gms. per 100 $\text{C}_6\text{H}_5\text{NaO}_2$ .	Gms. $\text{H}_2\text{O}$ . $\text{C}_7\text{H}_5\text{O}_2\text{Na}$ .	Solid Phase.	Gms. per 100 $\text{C}_6\text{H}_5\text{NaO}_2$ .	Gms. $\text{H}_2\text{O}$ . $\text{C}_7\text{H}_5\text{O}_2\text{Na}$ .	Solid Phase.
2.13	0	$\text{CaH}_9\text{N}_4\text{O}_2\cdot\text{H}_2\text{O}$	4.64	0	$\text{CaH}_9\text{N}_4\text{O}_2\cdot\text{H}_2\text{O}$
8.32	6.67	"	31.43	25.31	"
38.10	45	"	56.82	69.68	"
51.74	76.75	" + $\text{C}_7\text{H}_5\text{O}_2\text{Na}\cdot\text{H}_2\text{O}$	57.99	74.64	" + $\text{C}_7\text{H}_5\text{O}_2\text{Na}\cdot\text{H}_2\text{O}$
46.27	76.68	$\text{C}_7\text{H}_5\text{O}_2\text{Na}\cdot\text{H}_2\text{O}$	55.98	74.02	$\text{C}_7\text{H}_5\text{O}_2\text{Na}\cdot\text{H}_2\text{O}$
24.79	69.56	"	18.31	67.97	"
9.47	62.97	"	0	59.82	"
0	61.17	"			

**SOLUBILITY OF CAFFEINE IN AQUEOUS SOLUTIONS OF SODIUM SALICYLATE AND VICE VERSA.** (Pellini and Amadori, 1912.)

Results at 25°.			Results at 40°.		
Gms. per 100 $\text{C}_6\text{H}_5\text{NaO}_2$ .	Gms. $\text{H}_2\text{O}$ . $\text{C}_7\text{H}_5\text{O}_2\text{Na}$ .	Solid Phase.	Gms. per 100 $\text{C}_6\text{H}_5\text{NaO}_2$ .	Gms. $\text{H}_2\text{O}$ . $\text{C}_7\text{H}_5\text{O}_2\text{Na}$ .	Solid Phase.
2.13	0	$\text{CaH}_9\text{N}_4\text{O}_2\cdot\text{H}_2\text{O}$	4.64	0	$\text{CaH}_9\text{N}_4\text{O}_2\cdot\text{H}_2\text{O}$
38.36	30.76	"	59.49	37.47	"
55.23	47.31	"	86.49	62.47	"
74.32	68.81	"	95.94	69.15	"
16.78	124.96	$\text{C}_7\text{H}_5\text{O}_2\text{Na}$	26.93	131.52	$\text{C}_7\text{H}_5\text{O}_2\text{Na}$
13.22	121.27	"	10.75	124.35	"
9.03	120.54	"	0	119.66	"
0	115.43	"			

Data for the depression of the freezing-point of sodium salicylate solutions by caffeine and theobromine are also given.

**DISTRIBUTION OF CAFFEINE BETWEEN WATER AND CHLOROFORM.** (Marden, 1914.)

Grams Caffeine in:		Ratio of Caffeine in Equal Vols. $\text{H}_2\text{O}$ and $\text{CHCl}_3$ .
105 cc. $\text{H}_2\text{O}$ Layer.	50 cc. $\text{CHCl}_3$ Layer.	
0.0090	0.0563	0.0456
0.0180	0.1048	0.0492
0.0291	0.1770	0.0470

**CALCIUM ACETATE**  $\text{Ca}(\text{CH}_3\text{COO})_2\cdot 2\text{H}_2\text{O}$ .

**SOLUBILITY IN WATER.** (Lumsden, 1902; Krasnicki, 1827.)

Gms. $\text{Ca}(\text{CH}_3\text{COO})_2$ per 100 Gms.			Solid Phase.	Gms. $\text{Ca}(\text{CH}_3\text{COO})_2$ per 100 Gms.			Solid Phase.
°.	Solution.	Water.		°.	Solution.	Water.	
0	27.2	37.4	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$	60	24.6	32.7	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$
0	26.5	36.0	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$	80	25.1	33.5	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$
0	25.8	34.7	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$	84	25.3	33.8	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$
5	25.5	34.2	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$	85	24.7	32.9	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$
10	25.3	33.8	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$	90	23.7	31.1	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$
10	24.9	33.2	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$	100	22.9	29.7	$\text{Ca}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$

**SOLUBILITY OF CALCIUM ACETATE IN AN AQUEOUS SATURATED SOLUTION OF SUGAR AT 31.25°.** (Köhler, 1897.)

100 gms. solution contain 8.29 gms.  $\text{Ca}(\text{CH}_3\text{COO})_2$  + 60.12 gms. sugar.

100 gms. water dissolve 26.3 gms.  $\text{Ca}(\text{CH}_3\text{COO})_2$  + 190.3 gms. sugar.

100 cc. anhydrous hydrazine dissolve 1 gm. calcium acetate at room temp.

(Welsh and Broderson, 1915.)



# CALCIUM ACETATES

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**CALCIUM** (Tri) Methyl **ACETATE**  $\text{Ca}[(\text{CH}_3)_2\text{CCOO}]_2$ .

**CALCIUM** (Di) Ethyl **ACETATE**  $\text{Ca}[(\text{C}_2\text{H}_5)_2\text{CHCOO}]_2$ .

**CALCIUM** Methyl Ethyl **ACETATE**  $\text{Ca}[\text{CH}_3(\text{C}_2\text{H}_5)_2\text{CHCOO}]_2$ .

SOLUBILITY OF EACH IN WATER.

(Landau — Monatsh. Chem. 14, 717, '93; Keppish — *Ibid.* 9, 600, '88; Sedlitzki — *Ibid.* 8, 573, '87.

Ca. Tri Methyl Acetate. Ca. Di Ethyl Acetate. Ca. Methyl Ethyl

t°.	Gms. $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2$ per 100 Gms.		Gms. $\text{Ca}(\text{C}_2\text{H}_5\text{O}_2)_2$ per 100 Gms.		Gms. $\text{Ca}(\text{C}_2\text{H}_5\text{O}_2)_2$ per 100 Gms.	
	Water.	Solution.	Water.	Solution.	Water.	Solution.
0	7.30	6.81	30.3	23.22	28.78	22.35
10	6.84	6.40	27.8	21.75	31.71	24.07
20	6.54	6.14	25.6	20.38	33.76	25.23
30	6.40	6.01	23.7	19.16	34.92	25.89
40	6.44	6.05	22.1	18.10	35.20	26.04
50	6.64	6.22	20.8	17.22	34.60	25.71
60	6.86	6.42	19.9	16.60	33.11	24.89
70	7.11	6.64	19.2	16.11	30.74	23.41
80	7.38	6.87	...	...	27.49	21.56

**CALCIUM** Methyl Propyl **ACETATE**  $\text{Ca}[\text{CH}_3(\text{C}_2\text{H}_7)_2\text{CHCOO}]_2$ .

**CALCIUM** (Di) Propyl **ACETATE**  $\text{Ca}[(\text{C}_2\text{H}_7)_2\text{CHCOO}]_2$ .

**CALCIUM** (Iso) Butyl **ACETATE**  $\text{Ca}[(\text{CH}_3)_2\text{CH}(\text{CH}_2)_2\text{COO}]_2$ .

SOLUBILITY OF EACH IN WATER.

(Stiassny — Monatsh. Chem. 12, 596, '91; Furth — *Ibid.* 9, 313, '88; König — *Ibid.* 15, 22, '94.)

Ca. Methyl Propyl Acetate. Ca. Di Propyl Acetate. Ca. Iso Butyl

t°.	Gms. $\text{Ca}(\text{C}_4\text{H}_9\text{O}_2)_2$ per 100 Gms.		Gms. $\text{Ca}(\text{C}_4\text{H}_9\text{O}_2)_2$ per 100 Gms.		Gms. $\text{Ca}(\text{C}_4\text{H}_9\text{O}_2)_2$ per 100 Gms.	
	Water.	Solution.	Water.	Solution.	Water.	Solution.
0	16.58	14.22	9.57	8.73	7.48	6.96
10	15.80	13.65	8.35	7.71	6.38	5.99
20	15.14	13.15	7.19	6.71	5.66	5.36
30	14.61	12.75	6.11	5.77	5.31	5.04
40	14.21	12.45	5.09	4.84	5.31	5.04
50	13.94	12.24	4.14	3.98	5.68	5.37
60	13.79	12.13	3.25	3.15	6.41	6.02
70	13.78	12.12	2.44	2.38	7.51	6.98
80	13.89	12.20	1.65	1.62	8.97	8.23
90	...	...	...	...	10.79	9.74

**CALCIUM BENZOATE**  $\text{Ca}(\text{C}_6\text{H}_5\text{COO})_2$ .

100 cc. sat. solution in water contain 3.02 gms.  $\text{Ca}[\text{C}_6\text{H}_5\text{COO}]_2$  at 26°. (de Jong, 1912.

100 gms. sat. solution in water contain 8.6 gms.  $\text{Ca}[\text{C}_6\text{H}_5\text{COO}]_2$  at 15° and 10.1 gms. at 100°.

(Tarugi and Checchi, 1901.

**CALCIUM BORATES**  $\text{CaB}_2\text{O}_4 \cdot 4\text{H}_2\text{O}$ ,  $\text{CaB}_2\text{O}_4 \cdot 6\text{H}_2\text{O}$ .

SOLUBILITY OF EACH SEPARATELY IN WATER.

(Mandelbaum, 1909.)

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	$\text{B}_2\text{O}_3$ .	$\text{CaB}_2\text{O}_4$ .			$\text{B}_2\text{O}_3$ .	$\text{CaB}_2\text{O}_4$ .	
30	0.0365	0.310	$\text{CaB}_2\text{O}_4 \cdot 4\text{H}_2\text{O}$	30	0.0205	0.254	$\text{CaB}_2\text{O}_4 \cdot 6\text{H}_2\text{O}$
50	0.036	0.307	" (amorphous)	50	0.032	0.353	" (cryst.)
70	0.048	0.392	"	70	0.068	0.457	"
90	0.0315	0.310	"	90	0.0675	0.359	"



**SOLUBILITY OF CALCIUM BORATES IN AQUEOUS SOLUTIONS OF BORIC ACID  
AT 30°.**

(Sborgi, 1913.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
B <sub>2</sub> O <sub>3</sub>	CaO.		B <sub>2</sub> O <sub>3</sub>	CaO.	
0.014	0.126	Ca(OH) <sub>2</sub>	0.869	0.067	2.3.9
0.032	0.140	"	1.116	0.076	"
0.098	0.194	"	1.339	0.093	" + 1.3.12
0.127	0.217	" + 1.1.6	2.058	0.093	1.3.12
0.134	0.220	1.1.6	2.509	0.099	"
0.138	0.118	"	2.730	0.111	"
0.162	0.106	"	3.732	0.325	"
0.166	0.107	" + 2.3.9	2.798	0.109	"
0.171	0.109	" "	3.313	0.143	"
0.290	0.052	2.3.9	3.841	0.152	"
0.610	0.054	"	4.250	0.155	" + H <sub>2</sub> BO <sub>3</sub>
0.767	0.059	"	4.179	0.137	H <sub>2</sub> BO <sub>3</sub>

1.1.6 = CaO.B<sub>2</sub>O<sub>3</sub>.6H<sub>2</sub>O,    2.3.9 = 2CaO.3B<sub>2</sub>O<sub>3</sub>.9H<sub>2</sub>O,

1.3.12 = CaO.3B<sub>2</sub>O<sub>3</sub>.12H<sub>2</sub>O.

Many determinations, in addition to the above, are given in the original paper.

**CALCIUM BROMIDE** CaBr<sub>2</sub>.6H<sub>2</sub>O.

**SOLUBILITY IN WATER.**

(Kramers, 1858; Etard, 1894, gives results which yield an irregular curve and are evidently less accurate than those of Kramers.)

t°.	Gms. CaBr <sub>2</sub> per 100 Gms.		Solid Phase.	t°.	Gms. CaBr <sub>2</sub> per 100 Gms.		Solid Phase.
	Water. Solution.				Water. Solution.		
-22*	101	50.5	CaBr <sub>2</sub> .6H <sub>2</sub> O+Ice	34.2†	185	65.1	CaBr <sub>2</sub> .6H <sub>2</sub> O+CaBr <sub>2</sub> .4H <sub>2</sub> O
0	125	55.5	CaBr <sub>2</sub> .6H <sub>2</sub> O	40	213	68.1	CaBr <sub>2</sub> .4H <sub>2</sub> O
10	132	57	"	60	278	73.5	"
20	143	58.8	"	80	295	74.7	"
25	153	60.5	"	105	312	75.7	"

\* Eutec.

† tr. pt.

Density of saturated solution at 20° = 1.82.

Data for the system calcium bromide, calcium oxide and water at 25° are given by Milikau (1916).

Freezing-point data are given for mixtures of calcium bromide and calcium chloride, calcium bromide and calcium fluoride by Ruff and Plato, 1903.

**CALCIUM PERBROMIDE** CaBr<sub>4</sub>.

Data for the formation of calcium perbromide in aqueous solutions at 25° are given by Herz and Bulla (1911). The experiments were made by adding bromine to aqueous solutions of CaBr<sub>2</sub> and agitating with carbon tetrachloride. From the bromine content of the CCl<sub>4</sub> layer, the amount of free bromine in the aqueous layer can be calculated on the basis of the distribution ratio of bromine between water and CCl<sub>4</sub>. This furnishes the necessary data for calculating the amount of calcium perbromide existing in the aqueous layer.



# CALCIUM BUTYRATE

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**CALCIUM (Normal) BUTYRATE**  $\text{Ca}[\text{CH}_3(\text{CH}_2)_2\text{COO}]_2 \cdot \text{H}_2\text{O}$ .

**CALCIUM (Iso) BUTYRATE**  $\text{Ca}[(\text{CH}_3)_2\text{CH.COO}]_2 \cdot 5\text{H}_2\text{O}$ .

## SOLUBILITY OF EACH IN WATER.

(Lumsden — J. Chem. Soc. 81, 355, '02; see also Chancel and Parmentier — Compt. rend. 104, 6 '87; Desazathy — Monatsh. Chem. 14, 251, '93, and also Hecht — Liebigs Annalen 213, 72, '86, 8 results for the normal salt which are somewhat below those of Lumsden for the lower temperatures Sedlitzki — Monatsh. Chem. 8, 566, '87, gives slightly different results for the iso salt.)

Calcium Normal Butyrate.			Calcium Iso Butyrate.		
t°.	Gms. $\text{Ca}(\text{C}_4\text{H}_7\text{O}_2)_2$ per 100 Gms. Water. Solution.		t°.	Gms. $\text{Ca}(\text{C}_4\text{H}_7\text{O}_2)_2$ per 100 Gms. Water. Solution.	
0	20.31	16.89	0	20.10	16.78 $\text{Ca}(\text{C}_4\text{H}_7\text{O}_2)_2 \cdot 5\text{H}_2\text{O}$
10	19.15	16.08	20	22.40	18.30 "
20	18.20	15.39	30	23.80	19.23 "
25	17.72	15.05	40	25.28	20.65 "
30	17.25	14.71	60	28.40	22.12 "
40	16.40	14.09	62	28.70	22.30 "
60	15.15	13.16	65	28.25	22.03 $\text{Ca}(\text{C}_4\text{H}_7\text{O}_2)_2 \cdot \text{H}_2\text{O}$
80	14.95	13.01	80	27.00	21.26 "
100	15.85	13.69	100	26.10	20.69 "

**CALCIUM d CAMPHORATE**  $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Ca} \cdot 7\text{H}_2\text{O}$ .

SOLUBILITY OF CALCIUM CAMPHORATE IN AQUEOUS SOLUTIONS OF CAMPHORIC ACID AT 15° AND VICE VERSA.  
(Jungfleisch and Landrieu, 1914.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{C}_6\text{H}_8(\text{COOH})_2$ .	$\text{C}_{10}\text{H}_{16}\text{O}_4\text{Ca}$ .		$\text{C}_6\text{H}_8(\text{COOH})_2$ .	$\text{C}_{10}\text{H}_{16}\text{O}_4\text{Ca}$ .	
1.35	1.23	$\text{CaH}_4(\text{COOH})_2$	2.90	7.75	$\text{CaH}_4(\text{COOH})_2$
1.57	1.97	"	3	8.66	" + $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Ca} \cdot 7\text{H}_2\text{O}$
1.71	2.55	"	3.07	8.57	$\text{C}_{10}\text{H}_{16}\text{O}_4\text{Ca} \cdot 7\text{H}_2\text{O}$
2.18	4.34	"	1.50	7.94	"
2.33	4.73	"	0	7.37	"

Calcium camphorate tetrahydrate exists at higher temperatures. Its solubility at 100° was found to be 8.68 gms.  $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Ca}$  per 100 gms. sat. solut. By careful work, the result at 15° for  $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Ca} \cdot 4\text{H}_2\text{O}$  was found to be 1: gms.  $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Ca}$  per 100 gms. sat. solution.

**CALCIUM CAPROATE** (Hexoate)  $\text{Ca}[\text{CH}_3(\text{CH}_2)_4\text{COO}]_2 \cdot \text{H}_2\text{O}$ .

**CALCIUM 3 Methyl PENTANATE**  $\text{Ca}[\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{COO}]_2 \cdot 3\text{H}_2\text{O}$

**CALCIUM CAPEYLATE**  $\text{Ca}[\text{CH}_3(\text{CH}_2)_6\text{COO}]_2 \cdot \text{H}_2\text{O}$ .

## SOLUBILITY OF EACH IN WATER.

(Lumsden; the Pentanate, Kulsh, 1893; see also Keppish, 1888, and Altschul, 1896, for results on the Caproate.)

Ca. Caproate.		Ca. 3 Methyl Pentanate.		Ca. Caprylate.
t°.	Gms. Ca(C <sub>6</sub> H <sub>11</sub> O <sub>2</sub> ) <sub>2</sub> per 100 Gms. H <sub>2</sub> O.	Gms. Ca(C <sub>6</sub> H <sub>11</sub> O <sub>2</sub> ) <sub>2</sub> per 100 Gms.		Gms. Ca(C <sub>8</sub> H <sub>15</sub> O <sub>2</sub> ) <sub>2</sub> p 100 Gms. H <sub>2</sub> O.
		Water.	Solution.	
0	2.23	12.33	10.98	0.33
20	2.18	17.18	14.66	0.31
40	2.15	18.99	15.97	0.28
50	2.10	18.73	15.78	0.26
60	2.15	17.71	15.04	0.24
80	2.30	13.37	11.80	0.32
100	2.57	9.94	9.04	0.50



CALCIUM CARBONATE  $\text{CaCO}_3$ .EQUILIBRIUM IN THE SYSTEM  $\text{CaO-H}_2\text{O-CO}_2$  AT  $16^\circ$ .

Following data for the solubility of calcite ( $\text{CaCO}_3$ ) in water at  $16^\circ$  in contact with air containing the partial pressure  $P$  of  $\text{CO}_2$  were calculated from the data of Schloessing (1872), Engel (1888), and others by Johnston (1915) and by Johnston and Williamson (1916). These authors describe the changes in the solubility of calcite resulting from a gradual increase in partial pressure of  $\text{CO}_2$ , as follows:

begin by considering the equilibrium between the hydroxide  $\text{M(OH)}_2$  and the aqueous solution saturated with it as affected by a progressive increase from zero of the partial pressure of  $\text{CO}_2$  in the atmosphere in contact with the solution. Addition of  $\text{CO}_2$  is followed by a displacement between the vapor and liquid phases until there is equilibrium between the residual pressure of  $\text{CO}_2$  and the  $\text{H}_2\text{CO}_3$  in solution, and in turn between the latter and the solid; the net effect of this is a definite decrease in  $[\text{OH}^-]$ , the concentration of hydroxide ions; this necessitates that more of the hydroxide dissolve in order to keep the solubility-product  $[\text{M}^{++}][\text{OH}^-]^2$  constant. Consequently the total concentration of  $\text{M}^{++}$  increases, the  $\text{M}^{++}$  being now associated with carbonate and bicarbonate; in other words, the apparent solubility of the base increases if the method of analysis of the solution is a determination of the total  $\text{M}^{++}$  concentration; this would decrease if one should determine  $[\text{OH}^-]^2$ . This process continues until the product  $[\text{M}^{++}][\text{CO}_3^{--}]$  reaches the value requisite for the precipitation of  $\text{MCO}_3$  (on the assumption that supersaturation does not occur) which, for a given base, takes place at a definite value of  $P$  which depends only upon the temperature; this transition pressure  $P_1$  is, for a given temperature, the highest under which solid hydroxide is stable and the lowest at which solid carbonate is stable.

At  $P_1$  the solubility (as measured by the total  $[\text{M}]$ ) begins to diminish, because increase of partial pressure of  $\text{CO}_2$  increases  $[\text{CO}_3^{--}]$  while the product  $[\text{M}^{++}][\text{CO}_3^{--}]$  must remain constant so long as  $\text{MCO}_3$  is the stable solid phase; this increase of  $[\text{CO}_3^{--}]$  continues until a definite pressure  $P_2$  is reached, the formation of bicarbonate in the solution becomes the predominant reaction and the solubility begins to decrease again.  $P_2$  is thus a minimum in the solubility curve. With increase beyond  $P_2$  the concentration of both  $\text{M}^{++}$  and  $\text{HCO}_3^-$  increases steadily until the precipitation value of the product  $[\text{M}^{++}][\text{HCO}_3^-]$  is reached at  $P_3$ , which is a transition pressure at which both carbonate and bicarbonate are present as stable solid phases. At  $P_3$  bicarbonate alone is stable, and its total solubility falls off very slowly with increase of partial pressure of  $\text{CO}_2$ ."

CALCULATED ION-CONCENTRATIONS AND SOLUBILITY OF CALCITE IN CONTACT WITH AIR CONTAINING THE PARTIAL PRESSURE  $P$  OF  $\text{CO}_2$ .

Pressure $P$ Measured atmospheres.	Ion-concentrations per Liter $\times 10^{-4}$ .				Total Ca, Mols. per Liter $\times 10^{-4}$ .	Grams $\text{CaCO}_3$ per Liter.
	$\text{Ca}^{++}$ .	$\text{OH}^-$ .	$\text{CO}_3^{--}$ .	$\text{HCO}_3^-$ .		
$10^{-14}$	138.5	277	0.0071	0.0000235	...	2
$10^{-10}$	6.81	13.3	0.144	0.01	...	0.074
$10^{-9}$	2.377	3.82	0.414	0.10	...	0.026
$10^{-8}$	1.654	1.82	0.593	0.30	...	0.018
$10^{-7}$	1.476	1.02	0.665	0.60	...	0.016
$10^{-7}$	1.459	0.787	0.672	0.787	...	0.0159
$10^{-7}$	1.459	0.774	0.672	0.80	...	0.0159
$10^{-7}$	1.473	0.614	0.666	1	...	0.016
$10^{-6}$	2.051	0.147	0.478	3	...	0.022
$10^{-5}$	3.777	0.034	0.260	7	...	0.040
$10^{-4}$	5.197	0.0174	0.188	10	...	0.056
$10^{-4}$	5.09	0.0182	0.19	9.96	5.52	0.055
$10^{-4}$	5.46	0.0157	0.18	10.54	5.93	0.059
$10^{-4}$	5.79	0.0140	0.17	11.22	6.31	0.063
$10^{-4}$	6.08	0.0126	0.16	11.82	6.64	0.066
$10^{-4}$	6.35	0.0115	0.16	12.36	6.94	0.069
$10^{-4}$	6.59	0.0107	0.15	12.86	7.21	0.072
$10^{-4}$	6.82	0.0100	0.14	13.32	7.46	0.075



THE SOLUBILITY OF CALCIUM CARBONATE (CALCITE) IN WATER AT 16° IN CONTACT WITH AIR CONTAINING PARTIAL PRESSURE P OF CO<sub>2</sub>.

(Calc. from Schloesing, 1872, and Engel, 1888, by Johnston, 1915.)

Partial Pressure P of CO <sub>2</sub> in Atmospheres.	Total Ca, Mols. per Liter.	Total Ca(HCO <sub>3</sub> ) <sub>2</sub> Mols. per Liter.	Partial Pressure P of CO <sub>2</sub> in Atmospheres.	Total Ca, Mols. per Liter.	Total Ca(HCO <sub>3</sub> ) <sub>2</sub> Mols. per Liter.
0.000504	0.000746	0.000731	0.4167	0.007825	0.007874
0.000808	0.000850	0.000837	0.5533	0.008855	0.008854
0.00333	0.001372	0.001364	0.7297	0.00972	0.00972
0.01387	0.002231	0.002226	0.9841	0.01086	0.01086
0.02820	0.002965	0.002961	1	0.01085	0.01085
0.05008	0.003600	0.003597	2	0.01411	0.01411
0.1422	0.005330	0.005328	4	0.01834	0.01834
0.2538	0.006634	0.006632	6	0.02139	0.02139

THE SOLUBILITY OF CALCIUM CARBONATE (CALCITE) IN WATER AT 25° IN CONTACT WITH CO<sub>2</sub> UNDER INCREASING PRESSURES. (McCoy and Smith, 1911.)

Approx. Pressure of CO <sub>2</sub> in Atmospheres.*	Mols. per Liter Sat. Solution.		Gms. per Liter Sat. Sol.		Solid Phase.
	H <sub>2</sub> CO <sub>3</sub> .	Ca(HCO <sub>3</sub> ) <sub>2</sub> .	H <sub>2</sub> CO <sub>3</sub> .	Ca(HCO <sub>3</sub> ) <sub>2</sub> .	
0.1	0.003522	0.004116	0.22	0.67	CaCO <sub>3</sub>
1.1	0.03728	0.009734	2.3	1.58	"
9.9	0.3329	0.02236	20.6	3.62	"
13.2	0.444	0.02495	27.5	4.04	"
16.3	0.550	0.02600	34.1	4.21	Ca(HCO <sub>3</sub> ) <sub>2</sub>
25.4	0.858	0.02603	53.2	4.22	"

\* Calc. by Henry's Law from CO<sub>2</sub> concentrations. See also remarks under Ferrous Bicarbonate, p. 136.

These results show that the solution becomes saturated with Ca(HCO<sub>3</sub>)<sub>2</sub> at about 15 atmospheres pressure of CO<sub>2</sub>, and it would be theoretically possible to convert all the CaCO<sub>3</sub> to Ca(HCO<sub>3</sub>)<sub>2</sub> by introducing sufficient CO<sub>2</sub> at pressures greater than 15 atmospheres. Under the conditions of the present experiment, it was calculated that more than 3 months time would have been required for the complete conversion.

The solubility of calcium carbonate in water saturated with CO<sub>2</sub> at one atmosphere pressure was found by Cavazzi (1916) to be 1.56 gms. CaCO<sub>3</sub> at 0 and 1.1752 gms. at 15°. A supersaturated solution prepared by passing a rapid stream of CO<sub>2</sub> through sat. Ca(OH)<sub>2</sub> solution at 15° contained 2.29 gms. CaCO<sub>3</sub>.

SOLUBILITY OF CALCIUM CARBONATE IN WATER AT 15°. (Treadwell and Reuter, 1896.)

(Among the investigators who have reported results upon the solubility of calcium carbonate may be mentioned, Cossa, 1869; Schloesing, 1872; Caro, 1874; Reid, 1887-88; Irving and Young, 1888; Anderson, 1888-89; Engel, 1888; Lubavin, 1892; Pollacci, 1896.)

cc. CO <sub>2</sub> per 100 cc. Gaseous Phase (0° and 760 mm.).	Partial Pressure of CO <sub>2</sub> in mm. Hg.	Gms. per 100 cc. Saturated Solution.		
		Free CO <sub>2</sub> .	Ca(HCO <sub>3</sub> ) <sub>2</sub> .	Ca.
8.94	67.9	0.1574	0.1872	0.0462
6.04	45.9	0.0863	0.1755	0.0433
5.45	41.4	0.0528	0.1597	0.0394
2.18	16.6	0.0485	0.1540	0.0380
1.89	14.4	0.0347	0.1492	0.0368
1.72	13.1	0.0243	0.1331	0.0329
0.79	6	0.0145	0.1249	0.0308
0.41	3.1	0.0047	0.0821	0.0203
0.25	1.9	0.0029	0.0595	0.0147
0.08	0.6	...	0.0402	0.0099
...	...	...	0.0385	0.0095

Therefore 1 liter sat. solution at 15° and 0 partial pressure of CO<sub>2</sub> contains 0.385 gram Ca(HCO<sub>3</sub>)<sub>2</sub>. Determinations similar to the above, made in 0.1 NaCl solutions at 15°, are also given. It is pointed out by Johnston (1915), though Treadwell and Reuter made very painstaking analyses, their mode of working did not secure equilibrium conditions, a fact which is borne out by lack of constancy of the calculated solubility-product constant.



**SOLUBILITY OF CALCIUM CARBONATE (CALCITE) IN WATER IN CONTACT WITH AIR AT DIFFERENT TEMPERATURES.**

(Wells, 1915.)

(Joplin, Mo., calcite was used. The solutions were kept in a thermostat and agitated by a current of out-door air filtered through cotton and washed by water. The  $\text{CO}_2$  content of the air varied from 3.02 to 3.27 parts per 10,000. The calcium content of the solutions was determined by titrating with 0.02  $\text{N}$   $\text{NaHSO}_4$  using methyl orange as indicator. The solutions were slightly acid to phenolphthaleine, showing that the calcium was present chiefly as bicarbonate.)

t°.	Gms. $\text{CaCO}_3$ per Liter.
0	0.081
10	0.070
20	0.065
25	0.056 (0.046)
30	0.052
40	0.044
50	0.038 (0.029)

Results in parentheses by Kendall (1912). In connection with these it is stated by Johnston (1915), that assurance is wanting that the partial pressure of  $\text{CO}_2$  was the same at both temperatures and the results are, therefore, not necessarily comparable.

**SOLUBILITY OF CALCIUM CARBONATE IN WATER AT DIFFERENT TEMPERATURES AND IN CONTACT WITH AIR CONTAINING DIFFERENT PARTIAL PRESSURES OF  $\text{CO}_2$ .**

(Leather and Sen, 1909.)

Results at 15°.			Results at 25°.			Results at 40°.		
Partial Pressure $\text{CO}_2$ in Gas Phase.	Gms. per Liter Sol. $\text{CaCO}_3$ .	$\text{CO}_2$ .	Partial Pressure $\text{CO}_2$ in Gas Phase.	Gms. per Liter Sol. $\text{CaCO}_3$ .	$\text{CO}_2$ .	Partial Pressure $\text{CO}_2$ in Gas Phase.	Gms. per Liter Sol. $\text{CaCO}_3$ .	$\text{CO}_2$ .
0.8	0.193	0.117	0.7	0.159	0.091	0.6	0.136	0.078
1.5	0.193	0.152	1.6	0.177	0.111	1.7	0.143	0.085
1.7	0.238	0.135	4.6	0.341	0.208	2.9	0.175	0.106
6.8	0.445	0.327	7.8	0.446	0.301	3.5	0.232	0.169
9.9	0.627	0.456	16.5	0.539	0.522	7	0.284	0.234
13.6	0.723	0.560	30.1	0.743	0.715	14.9	0.384	0.293
14.6	0.686	0.623	35.5	0.755	0.803	22.2	0.427	0.333
31.6	1.050	1.117				31.7	0.480	0.476

Similar results also given for 20°, 30° and 35°.

The mixtures were constantly agitated at constant temperature. The solid phase in each case was found to be  $\text{CaCO}_3$  and it is concluded that  $\text{Ca}(\text{HCO}_3)_2$  cannot exist in this solid state above 15°.

In discussing the experiments of Leather and Sen, Johnston (1915) points out that their method of analysis gives low results for  $\text{CO}_2$ . A calculation of the data yields very irregular results and the most that can be deduced from them is that the solubility-product constant of calcite probably decreases somewhat with temperature, becoming apparently about  $0.5 \times 10^{-8}$  at 40°.

Data for the solubility of  $\text{CaCO}_3$  in boiling water are given by Cavazzi (1917).

Data for the solubility of calcium carbonate in water containing excess of carbon dioxide are also given by Seyler and Lloyd (1909). The experiments were made at room temperature. Additional experiments showed that small amounts of  $\text{CaCl}_2$ ,  $\text{CaSO}_4$  or  $\text{NaHCO}_3$  did not affect the solubility-product constant. Small amounts of  $\text{NaCl}$ ,  $\text{Na}_2\text{SO}_4$  and  $\text{MgSO}_4$ , containing no ion in common with  $\text{CaCO}_3$ , resulted in an increase of the total calcium in the solution.

Data for the solubility of calcium carbonate in water, determined by the conductivity method, are given by Holleman and by Kohlrausch and Rose (1893).



# CALCIUM CARBONATE

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## SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE.

Results at 12°-18°. (Cantoni and Goguelis, 1905.)  
(Flasks allowed to stand 98 days.)

Gms. per Liter Sat. Sol.	
NH <sub>4</sub> Cl.	CaCO <sub>3</sub> .
53.5	0.423
100	0.609
200	0.645

Results at 25°. (Rindell, 1910.)  
(Constant agitation 24 hrs.)

Gms. per Liter Sat. Sol.	
NH <sub>4</sub> Cl.	CaCO <sub>3</sub> .
6.7	0.285
13.4	0.373
26.8	0.502
53.5	0.678

Results at 60° for Calcite and Aragonite. (Warynski and Kourapatwinaka, 1916.)

Gms. per Liter.		Gms. per Liter.
NH <sub>4</sub> Cl.	Calcite.	NH <sub>4</sub> Cl.
0	0.028	0
1.07	0.164	1.07
5.35	0.333	5.35
10.70	0.453	10.70
26.76	0.664	26.76
53.52	0.934	53.52
160.56	1.21	160.56

## SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SOLUTIONS OF AMMONIUM NITRATE AND OF TRIAMMONIUM CITRATE.

In Aq. NH<sub>4</sub>NO<sub>3</sub> at 18°. In Aq. NH<sub>4</sub>NO<sub>3</sub> at 25°. In Aq. Triammonium Citrate at 25°. (Berju and Kosminiko, 1904.) (Rindell, 1910.) (Rindell, 1910.)

Gms. per Liter Sat. Sol.	
NH <sub>4</sub> NO <sub>3</sub> .	CaCO <sub>3</sub> .
0	0.131
5	0.211
10	0.258
20	0.340
40	0.462
80	0.584

Gms. per Liter Sat. Sol.	
NH <sub>4</sub> NO <sub>3</sub> .	CaCO <sub>3</sub> .
5	0.200
10	0.278
20	0.383
40	0.526

Mols. Citrate per Liter.	Gms. CaCO <sub>3</sub> per Liter.
0.0625	1.492
0.125	2.264
0.250	3.980
0.500	6.687

## SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SOLUTIONS OF MAGNESIUM CHLORIDE, MAGNESIUM SULFATE, SODIUM CHLORIDE AND SODIUM SULFATE UNDER CO<sub>2</sub> PRESSURE OF TWO ATMOSPHERES. (Ehlert and Hempel, 1912.)

Aq. Salt Solution.	°.	Gms. Hydrated Salt per 1000 Gms. H <sub>2</sub> O.	Gms. CaCO <sub>3</sub> per 1000 cc. Solvent.	Aq. Salt Solution.	°.	Gms. Hydrated Salt per 1000 Gms. H <sub>2</sub> O.	Gms. CaCO <sub>3</sub> per 1000 cc. Solvent.
MgCl <sub>2</sub> ·6H <sub>2</sub> O	5	0	2.337	NaCl	5	50	3.740
"	5	6.1	2.352	"	5	86	3.783
"	5	50	3.404	"	5	106.9	3.690
"	5	86.9	4.083	"	5	175.6	3.350
"	5	350	3.301	"	5	263.4	2.811
"	5	700	2.736	"	8	351.2	2.163
"	5	1150	2.205	MgSO <sub>4</sub> ·7H <sub>2</sub> O	14	105.3	2.177
"	5	1725	1.706	" (sat.)	14	(sat.)	0.914
"	5	2300 sat.	1.406	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O	14	137.7	1.406
NaCl	5	28	3.280	" (sat.)	14	(sat.)	1.920

## SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE AND OF POTASSIUM SULFATE AT 25°. (Cameron and Robinson, 1907.)

Results for Aqueous KCl:

In contact with air.	In contact with 1 atmosphere of CO <sub>2</sub> .
Gms. per 100 Gms. Sat. Sol.	Gms. per 100 Gms. Sat. Sol.
KCl.	CaCO <sub>3</sub> .
0	0.0013
3.9	0.0078
7.23	0.0078
13.82	0.0072
18.21	0.0070
26	0.0060

Results for Aqueous K<sub>2</sub>SO<sub>4</sub>:

In contact with air.	In contact with 1 atmosphere of CO <sub>2</sub> .
Gms. per 100 Gms. Sat. Sol.	Gms. per 100 Gms. Sat. Sol.
K <sub>2</sub> SO <sub>4</sub> .	CaCO <sub>3</sub> .
1.60	0.0104
3.15	0.0116
4.73	0.0132
6.06	0.0148
8.88	0.0192
10.48	0.0188

\* Solid phase syngenite.

One liter aqueous solution containing 223.8 gms. KCl dissolves 0.075 gm. calcite at 60°.

One liter aqueous solution containing 223.8 KCl dissolves 0.093 gm. aragonite at 60°.

(Warynski and Kourapatwinaka, 1916.)



**SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE AT 25°.**

Solutions in contact with.

CO <sub>2</sub> Free Air. (Cameron, Bell and Robinson, 1907.)		Ordinary Air. (Cameron and Seidell, 1902.)		CO <sub>2</sub> at One Atmos. Pressure. (Cameron, Bell and Robinson, 1907.)	
Gms. per 100 Gms. H <sub>2</sub> O.		Gms. per 100 cc. Sat. Sol.		Gms. per 100 Gms. H <sub>2</sub> O.	
NaCl.	CaCO <sub>3</sub> .	NaCl.	CaCO <sub>3</sub> .	NaCl.	CaCO <sub>3</sub> .
1.60	0.0079	1	0.0112	1.49	0.150
5.18	0.0086	4	0.0140	5.69	0.160
9.25	0.0094	8	0.0137	11.06	0.174
11.48	0.0104	10	0.0134	15.83	0.172
16.66	0.0106	15	0.0119	19.62	0.159
22.04	0.0115	20	0.0106	29.89	0.123
30.50	0.0119	25	0.0085	35.85	0.103

Data for the solubility of calcium carbonate in aqueous solutions of mixtures of sodium chloride and sodium sulfate in contact with air and with CO<sub>2</sub> are given by Cameron, Bell and Robinson (1907).

Data for solubility of CaCO<sub>3</sub> in aqueous NaCl and other salt solutions, determined by boiling and cooling the solution, are given by Gothe (1915).

Data for the solubility of mixtures of calcium carbonate and calcium sulfate in aqueous solutions of sodium chloride at 25° are given by Cameron and Seidell (1901).

Data for the solubility of mixtures of calcium carbonate and calcium sulfate in aqueous solutions of mixtures of sodium chloride and sodium sulfate at 25°, in contact with air and with CO<sub>2</sub>, are given by Cameron, Bell and Robinson (1907).

One liter aqueous solution containing 175.5 gms. NaCl dissolves 0.062 gm. calcite at 60°.

One liter aqueous solution containing 175.5 gms. NaCl dissolves 0.071 gm. aragonite at 60°.

(Warynski and Kourapatwinska, 1916.)

**SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SOLUTIONS OF SODIUM HYDROXIDE IN CONTACT WITH CO<sub>2</sub> FREE AIR.**

(LeBlanc and Novotny, 1906.)

Solvent.	Gms. CaCO <sub>3</sub> per Liter Sat. Sol.	
	At 18°.	At 95°-100°.
Water	0.0128	0.0207
About 0.0001 % NaOH	0.0087	0.0096
" 0.0010 % "	0.0042	0.0069
" 0.0100 % "	0.0042	0.0057

Data on the equilibrium in aqueous solutions of CaCO<sub>3</sub>, Na<sub>2</sub>CO<sub>3</sub> and NaOH are given by Wegscheider and Walter (1907).

**SOLUBILITY OF CALCIUM CARBONATE IN AQUEOUS SOLUTIONS OF SODIUM SULFATE.**

Solutions in contact with:

CO <sub>2</sub> Free Air at 25°. (Cameron, Bell and Robinson, 1907.)		Ordinary Air at 24°. (Cameron and Seidell, 1902.)	
Gms. per 100 Gms. H <sub>2</sub> O.		Gms. Na <sub>2</sub> SO <sub>4</sub> per Liter.	
Na <sub>2</sub> SO <sub>4</sub> .	CaCO <sub>3</sub> .	Gms. Total Ca per Liter Calc. as Ca(HCO <sub>3</sub> ) <sub>2</sub> .	
0.97	0.0151	5	0.175
1.65	0.0180	10	0.232
4.90	0.0262	20	0.277
12.69	0.0313	40	0.332
14.55	0.0322	80	0.400
19.38	0.0346	150	0.510
23.90	0.0360	250	0.725

Freezing-point data for mixtures of calcium carbonate and calcium chloride are given by Sackur (1911-12).



# CALCIUM CHLORATE

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## CALCIUM CHLORATE $\text{Ca}(\text{ClO}_3)_2 \cdot 2\text{H}_2\text{O}$ .

100 grams saturated aqueous solution contain 64 grams  $\text{Ca}(\text{ClO}_3)_2$  at 18°. Density of solution is 1.729. (Mylius and Funk, 1897.)

## CALCIUM CHLORIDE $\text{CaCl}_2$ .

### SOLUBILITY IN WATER

(Roozeboom — Z. physik. Chem. 4, 42, '80; see also Mulder; Ditte — Compt. rend. 92, 242, '81; Ergl — Ann. chim. phys. [6] 13, 381, '88; Etard — *Ibid.* [7] 2, 532, '94.)

t°.	Gms. $\text{CaCl}_2$ per 100 Gms.		Solid Phase.	t°.	Gms. $\text{CaCl}_2$ per 100 Gms.		Solid Phase.
	Water.	Solution.			Water.	Solution.	
-55	42.5	29.8	Ice + $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	60	136.8	57.8	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
-25	50.0	33.3	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	70	141.7	58.6	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
0	59.5	37.3	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	80	147.0	59.5	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
10	65.0	39.4	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	90	152.7	60.6	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
20	74.5	42.7	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	100	159.0	61.4	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
30.2	102.7	50.7	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$	120	173.0	63.4	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
20	91.0	47.6	$\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$	140	191.0	65.6	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
29.8	100.6	50.1	$4\text{H}_2\text{O} \alpha + 6\text{H}_2\text{O}$	160	222.5	69.0	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
40	115.3	53.4	$4\text{H}_2\text{O} \alpha$	170	255.0	71.8	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
20	104.5	51.1	$\text{CaCl}_2 \cdot 4\text{H}_2\text{O} \beta$	175.5	297.0	74.8	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ + $\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$
29.2	112.8	53.0	$4\text{H}_2\text{O} \beta + 6\text{H}_2\text{O}$	180	300.0	75.0	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
35	122.5	55.0	$4\text{H}_2\text{O} \beta$	200	311.0	75.7	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
38.4	127.5	56.0	$4\text{H}_2\text{O} \beta + \text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	235	332.0	76.8	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
45.3	130.2	56.6	$4\text{H}_2\text{O} \alpha + \text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	260	347.0	77.6	$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$

Density of saturated solution at 0° = 1.367, at 15° = 1.399, at 18° = 1.417; at 25° = 1.47.

### SOLUBILITY OF CALCIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 0°.

(Engel, 1887.)

Gms. per 100 cc. Sat. Sol.		$d_4$ of Sat. Sol.	Gms. per 100 cc. Sat. Sol.		$d_4$ of Sat. Sol.
$\text{CaCl}_2$ .	HCl.		$\text{CaCl}_2$ .	HCl.	
51.45	0	1.367	29.84	15.84	1.283
46.45	3.32	1.344	20.12	23.15	1.250
42.80	5.83	1.326	11.29	34.62	1.238
36.77	10.66	1.310			

### SOLUBILITY OF MIXTURES OF CALCIUM CHLORIDE, MAGNESIUM CHLORIDE AND CALCIUM MAGNESIUM DOUBLE CHLORIDE (TACHYDRITE).

(Van't Hoff and Kenrick, 1912.)

t°.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .		Solid Phase.
	$\text{CaCl}_2$ .	$\text{MgCl}_2$ .	
16.7	41.2	31.6	$\text{MgCl}_2 \cdot 6\text{H}_2\text{O} + \text{CaCl}_2 \cdot 6\text{H}_2\text{O}$
21.95	57.1	26	" " + Tachydrate
28.2	54.5	28.4	Tachydrate + $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$
116.7	0	85.63	" + " + $\text{MgCl}_2 \cdot 4\text{H}_2\text{O}$
25	32.3	17.9	+ $\text{CaCl}_2 \cdot 6\text{H}_2\text{O} + \text{CaCl}_2 \cdot 4\text{H}_2\text{O}$
28.2	80.1	16.1	" + $\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$
28.2	88.7	7.24	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O} + \text{CaCl}_2 \cdot 4\text{H}_2\text{O}$

Tachydrate =  $2\text{MgCl}_2 \cdot \text{CaCl}_2 \cdot 12\text{H}_2\text{O}$ .

100 grams  $\text{H}_2\text{O}$  dissolve 63.5 grams  $\text{CaCl}_2$  + 4.9 grams  $\text{KCl}$  at 7° (M).

100 grams  $\text{H}_2\text{O}$  dissolve 57.6 grams  $\text{CaCl}_2$  + 2.4 grams  $\text{NaCl}$  at 4° (M).

100 grams  $\text{H}_2\text{O}$  dissolve 59.5 grams  $\text{CaCl}_2$  + 4.6 grams  $\text{NaCl}$  at 7° (M).

100 grams  $\text{H}_2\text{O}$  dissolve 72.6 grams  $\text{CaCl}_2$  + 16 grams  $\text{NaCl}$  at 15° (R).

(M) = Mulder. (R) = Rüdorff.



### SOLUBILITY OF CALCIUM CHLORIDE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE AT 25° AND VICE VERSA.

(Cameron, Bell and Robinson, 1907.)

$d_{20}^{25}$ sat. Sol.	Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.	$d_{25}^{25}$ Sat. Sol.	Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.
	CaCl <sub>2</sub>	NaCl.			CaCl <sub>2</sub>	NaCl.	
...	84	0	CaCl <sub>2</sub> ·6H <sub>2</sub> O	1.2653	30.08	10.70	NaCl
1.4441	78.49	1.846	" + NaCl	1.2367	19.53	18.85	"
1.3651	58.48	1.637	NaCl	1.2080	3.92	32.48	"
1.3463	53.47	1.799	"	1.2030	0	35.80	"
1.2831	36.80	7.77	"				

### SOLUBILITY OF CALCIUM CHLORIDE IN AQUEOUS ALCOHOL AT ROOM TEMPERATURE.

(Bödtker, 1897.)

Solution Used.	Vol. Per Cent Alcohol.	Gms. CaCl <sub>2</sub> per 5 cc. Sol.	Solution Used.	Vol. Per Cent Alcohol.	Gms. CaCl <sub>2</sub> per 5 cc. Sol.
15 Gms. CaCl <sub>2</sub> ·6H <sub>2</sub> O + 20 cc. alcohol	92.3	1.430	15 Gms. CaCl <sub>2</sub> ·6H <sub>2</sub> O + 20 cc. alcohol + 2 Gms. CaCl <sub>2</sub>	99.3	1.561
15 Gms. CaCl <sub>2</sub> ·6H <sub>2</sub> O + 20 cc. alcohol	97.3	1.409	" + 3 " "	99.3	1.590
15 Gms. CaCl <sub>2</sub> ·6H <sub>2</sub> O + 20 cc. alcohol	99.3	1.429	" + 4 " "	99.3	1.641
15 Gms. CaCl <sub>2</sub> ·6H <sub>2</sub> O + 20 cc. alcohol			" + 5 " "	99.3	1.709
15 Gms. CaCl <sub>2</sub> ·6H <sub>2</sub> O + 20 cc. alcohol					
+ 1 Gm. CaCl <sub>2</sub>	99.3	1.529			

### SOLUBILITY OF CALCIUM CHLORIDE IN AQUEOUS SOLUTIONS OF ACETONE AT 20°.

(Frankforter and Cohen, 1914.)

Measured amounts of acetone were added to known solutions of CaCl<sub>2</sub> in water, until opalescence, indicative of the separation of a second liquid layer, was observed. The composition of a large number of such mixtures gives the limiting values for the binodal curve of the system. Tie lines were also determined in several instances by using such quantities of the three components that an adequate amount of each layer would be formed to permit the determination of the CaCl<sub>2</sub> in it. The points thus located on the curve fix the tie lines, and from them the approximate position of the plait point can be estimated.

#### Points on the Binodal Curve at 20°.

#### Composition of Points Representing Tie Lines at 20°.

Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Upper Layer. Gms. per 100 Gms. Lower Layer.			
Acetone.	CaCl <sub>2</sub>	Acetone.	CaCl <sub>2</sub>	Acetone.	CaCl <sub>2</sub>
9	40.5 <sup>*</sup>	90.2	0.186	28.5	16.61
22.7	38.16†	83.3	0.628	34.6	12.97
20.8	31.2	81	0.948	40	10.6
20.2	28	78.5	1.321	43.5	9.36
21	24.4	60	5 (plait point)	60	5
23	21.1				
25	19.2				
30	15.6				
35	12.8				
40	10.5				
45	8.8				
50	7.4				
55	6.1				
60	5				
65	3.9				
70	2.8				
75	1.8				
80	1				
85	0.5				
90	0.2				
95	0.1				

Point on solubility curve. † Quadruple point. 40

#### Points on the Binodal Curve at Different Temperatures.

Gms. per 100 Gms. Sat. Sol.

Acetone. CaCl<sub>2</sub>

31.09 15.52

22.77 23.64

31.09 15.52

30.58 15.27

21.44 22.25

29.83 14.89

20.99 21.79

29.27 14.62

21.14 20.91

28.59 14.29

19.83 20.58

27.90 13.93



# CALCIUM CHLORIDE

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## SOLUBILITY OF CALCIUM CHLORIDE IN A SATURATED SOLUTION OF SUGAR AT 31.25°. (Köhler, 1897.)

100 grams saturated solution contain 42.84 grams sugar + 25.25 grams  $\text{CaCl}_2$ , or 100 grams water dissolve 135.1 grams sugar + 79.9 grams  $\text{CaCl}_2$ .

100 gms. 95% formic acid dissolve 43.1 gms.  $\text{CaCl}_2$  at 19°. (Aschan, 1913.)

100 cc. anhydrous hydrazine dissolve 16 gms.  $\text{CaCl}_2$  at room temp. (Welsh and Broderson, 1915.)

100 gms. propyl alcohol dissolve 10.75 gms.  $\text{CaCl}_2$  (temp.?). (Schlamp, 1894.)

## FREEZING-POINT DATA (Solubility, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES OF CALCIUM CHLORIDE AND OTHER SALTS.

$\text{CaCl}_2 + \text{CaF}_2$ (1) (2)	$\text{CaCl}_2 + \text{PbCl}_2$ (5) (6) (7)	$\text{CaCl}_2 + \text{AgCl}$ (5)
$\text{CaCl}_2 + \text{CaI}_2$ (1)	$\text{CaCl}_2 + \text{LiCl}$ (7) (8)	$\text{CaCl}_2 + \text{SrCl}_2$ (6) (7) (3) (10)
$\text{CaCl}_2 + \text{CaO}$ (3)	$\text{CaCl}_2 + \text{MgCl}_2$ (5) (6)	$\text{CaCl}_2 + \text{SrO}$ (3)
$\text{CaCl}_2 + \text{CaSiO}_3$ (4)	$\text{CaCl}_2 + \text{MnCl}_2$ (6) (7)	$\text{CaCl}_2 + \text{TlCl}$ (9)
$\text{CaCl}_2 + \text{CaSO}_4$ (3)	$\text{CaCl}_2 + \text{KCl}$ (5) (3)	$\text{CaCl}_2 + \text{SnCl}_2$ (5)
$\text{CaCl}_2 + \text{CuCl}$ (5)	$\text{CaCl}_2 + \text{NaCl}$ (5) (3)	$\text{CaCl}_2 + \text{ZnCl}_2$ (5)

(1) = Ruff and Plato, 1903; (2) = Plato, 1907; (3) = Sackur, 1911-12; (4) = Karandeeff, 1910; (5) = Menge, 1911; (6) = Sandonnini, 1911; (7) = Sandonnini, 1913; (8) = Sandonnini, 1913; (9) = Kereng, 1914; (10) = Schaefer, 1914.

## CALCIUM CHLORIDE ACETAMIDATE $\text{CaCl}_2 \cdot 3\text{CH}_3\text{CONH}_2$ .

### SOLUBILITY IN ACETAMIDE AT VARIOUS TEMPERATURES, DETERMINED BY THE SYNTHETIC METHOD. (Menschutkin, 1908.)

t°.	Gms. per 100 Gms. Sat. Sol. $\{\text{CaCl}_2 \cdot 3\text{CH}_3\text{CONH}_2\} = \text{CaCl}_2$ .		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol. $\{\text{CaCl}_2 \cdot 3\text{CH}_3\text{CONH}_2\} = \text{CaCl}_2$ .		Solid Phase.
82 m. pt.	0	0	$\text{CH}_3\text{CONH}_2$	100	65.6	25.3	1.3
78	8	3.1	"	150	70.5	27.1	"
74	15.4	5.9	"	165	74.8	28.8	"
66	27	10.4	"	175	80.6	31	"
54	39.2	15.1	"	180	85.5	32.9	"
46 Eutec.	45	17.3	" +1.6	184	90.5	34.8	"
58	48.5	18.7	1.6	186 tr. pt.	94.5	36.4	" + $\text{CaCl}_2$ (?)
62	54.5	21	"	200	97.5	37.5	$\text{CaCl}_2$ (?)
64 tr. pt.	62.1	23.9	1.6 + 1.3	210	100	38.5	"

1.6 =  $\text{CaCl}_2 \cdot 6\text{CH}_3\text{CONH}_2$ .

1.3 =  $\text{CaCl}_2 \cdot 3\text{CH}_3\text{CONH}_2$ .

## CALCIUM CHLORIDE ACETIC ACIDATE $\text{CaCl}_2 \cdot 4\text{CH}_3\text{COOH}$ .

### SOLUBILITY IN ACETIC ACID AT VARIOUS TEMPERATURES, DETERMINED BY THE SYNTHETIC METHOD. (Menschutkin, 1906.)

t°.	Gms. per 100 Gms. Sat. Sol. $\{\text{CaCl}_2 \cdot 4\text{CH}_3\text{COOH}\} = \text{CaCl}_2$ .		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol. $\{\text{CaCl}_2 \cdot 4\text{CH}_3\text{COOH}\} = \text{CaCl}_2$ .		Solid Phase.
16.2 m. pt.	0	0	$\text{CH}_3\text{COOH}$	40	54.7	17.3	1.4
15	18	5.7	"	45	63	19.9	"
14	27	8.5	"	50	69.5	21.9	"
13	34	10.7	"	60	79.5	25.1	"
11.1 Eutec.	42	13.3	" +1.4	65	84.5	26.7	"
30	47.6	15	1.4	70	91.2	28.8	"
35	50	15.8	"	73 m. pt.	100	31.6	"

1.4 =  $\text{CaCl}_2 \cdot 4\text{CH}_3\text{COOH}$ .



**CALCIUM CHLORIDE ALCOHOLATES**  $\text{CaCl}_2 \cdot 3\text{CH}_2\text{OH}$ ,  $\text{CaCl}_2 \cdot 3\text{C}_2\text{H}_5\text{OH}$ .

(The compounds were prepared by mixing anhydrous  $\text{CaCl}_2$  with the alcohol. In the case of the methyl alcohol compound, the tri  $\text{CH}_2\text{OH}$  salt crystallizes above  $55^\circ$ , the tetra salt below this temperature.)

**SOLUBILITY OF EACH IN THE RESPECTIVE ALCOHOL AT VARIOUS TEMPERATURES, DETERMINED BY THE SYNTHETIC METHOD.**  
(Menschutkin, 1906.)

Results for $\text{CaCl}_2 \cdot 3\text{CH}_2\text{OH}$ .				Results for $\text{CaCl}_2 \cdot 3\text{C}_2\text{H}_5\text{OH}$ .			
t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	$\text{CaCl}_2 \cdot 3\text{CH}_2\text{OH} = \text{CaCl}_2$				$\text{CaCl}_2 \cdot 3\text{C}_2\text{H}_5\text{OH} = \text{CaCl}_2$		
0	33.3	17.85	1.4	95	66.3	35.5	1.3
10	37.6	20.15	"	115	70.3	37.6	"
20	42.2	22.6	"	135	75.2	40.3	"
30	47	25.2	"	155	81.8	43.8	"
40	52	27.8	"	165	86.2	46.2	"
50	57.3	30.7	"	170	89.5	47.9	"
55	60	32.1	"	174	93.5	50.1	"
56	61.3	32.8	"	177*	100	53.6	"
55	60.5	32.4	" + 1.3	190	...	55.7	1.1(?)
75	63.1	33.8	1.3	215	...	57.7	"
							97*
							100

\* M. pt.

1.4 =  $\text{CaCl}_2 \cdot 4\text{CH}_2\text{OH}$ . 1.3 =  $\text{CaCl}_2 \cdot 3\text{CH}_2\text{OH}$ , 1.1 =  $\text{CaCl}_2 \cdot \text{CH}_2\text{OH}$ .**CALCIUM CHROMATE**  $\text{CaCrO}_4$ .**SOLUBILITY OF THE SEVERAL HYDRATES IN WATER.**

(Mylus and Wrochem — Wiss. Abh. p. t. Reichanstalt 3, 462, '00.)

t°.	Gms. $\text{CaCrO}_4$ per 100 Gms.		Mols. $\text{CaCrO}_4$ per 100 Mols. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{CaCrO}_4$ per 100 Gms.		Mols. $\text{CaCrO}_4$ per 100 Mols. $\text{H}_2\text{O}$ .
	Water.	Solution.			Water.	Solution.	
Solid Phase, $\alpha$ $\text{CaCrO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ . (Monoclinic.)				Solid Phase, $\text{CaCrO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ .			
0	17.3	14.75	2.0	0	7.3	6.8	0.84
18	16.68	14.3	1.93	18	4.8	4.4	0.51
20	16.6	14.22	1.93	31	3.84	3.7	0.44
30	16.5	13.89	1.85	38.5	2.67	2.6	0.31
45	14.3	12.53	1.65	50	1.63	1.6	0.19
Solid Phase, $\beta$ $\text{CaCrO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ (Rhombic.)				60	1.13	1.1	0.13
0	10.9	9.8	1.25	100	0.81	0.8	0.09
13	11.5	10.3	1.33	Solid Phase, $\text{CaCrO}_4$ .			
40	11.6	10.4	1.34	0	4.5	4.3	0.52
Solid Phase, $\text{CaCrO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ .				18	2.32	2.27	0.27
0	13.0	11.5	1.50	31	2.92	1.89	0.22
18	10.6	9.6	1.22	50	1.12	1.11	0.13
25	10.0	9.1	1.15	60	0.83	0.82	0.11
40	8.5	7.8	0.98	70	0.80	0.79	0.09
60	6.1	5.7	0.70	100	0.42	0.42	0.05
75	4.8	4.6	0.56				
100	3.2	3.1	0.37				

Densities of the saturated solutions of the above several hydrates at  $18^\circ$  are:  $\alpha$   $\text{CaCrO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ , 1.149;  $\beta$   $\text{CaCrO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ , 1.105;  $\text{CaCrO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ , 1.096;  $\text{CaCrO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ , 1.044;  $\text{CaCrO}_4$ , 1.023.

100 cc. 29% alcohol dissolve 1.206 grams  $\text{CaCrO}_4$ .100 cc. 53% alcohol dissolve 0.88 gram  $\text{CaCrO}_4$ .

(Fresenius — Z. anal. Chem. 30, 672, '91.)



# CALCIUM CINNAMATES

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## CALCIUM CINNAMATE $\text{Ca}(\text{C}_6\text{H}_5\text{CH}:\text{CHCOO})_2 \cdot 3\text{H}_2\text{O}$ .

SOLUBILITY OF CALCIUM CINNAMATE AND ITS ISOMERS IN SEVERAL SOLVENTS.

Name of Salt.	Formula.	Solvent.	t°.	Gms. Anhydrous Salt per 100 Gms. Solvent.
Calcium Cinnamate	$\text{Ca}(\text{C}_6\text{H}_5\text{CH}:\text{CHCOO})_2 \cdot 3\text{H}_2\text{O}$	Water	2	0.19(1)
"	"	"	15	0.21(4)
"	"	"	26	0.24(1)
"	"	"	100	1.15(2)
" Isocinnamate	$\text{Ca}(\text{C}_6\text{H}_5\text{O})_2 \cdot 2\text{H}_2\text{O}$	"	20	23.8 (3)
"	"	Acetone	20	19.5 (3)
" Allocinnamate	$\text{Ca}(\text{C}_6\text{H}_5\text{O})_2 \cdot 3\text{H}_2\text{O}$	"	20	2 (3)
"	$\text{Ca}(\text{C}_6\text{H}_5\text{O})_2 \cdot 2\text{H}_2\text{O}$	Water	20	10.2 (4)
"	"	Acetone	18	2.7 (3)
" Hydrocinnamate	$\text{Ca}(\text{C}_6\text{H}_5\text{O})_2 \cdot \text{H}_2\text{O}$	"	14	0.19(3)
"	"	"	19	0.21(3)
"	"	Water	27	4.25(3)
"	"	Acetone	25	3.3 (3)

(1) = De Jong, 1909; (2) = Tarugi and Checchi, 1901; (3) = Michael, 1901; (4) = Lieberman, 1903; (5) = Michael and Garner, 1903.

## CALCIUM CITRATE $\text{Ca}_3(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 4\text{H}_2\text{O}$ .

SOLUBILITY IN WATER AND IN ALCOHOL AT 18° AND AT 25°.  
(Partheil and Hübner, 1903.)

Solvent.	Grams $\text{Ca}_3(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot 4\text{H}_2\text{O}$ per 100 Gms. Solvent at:	
	18°.	25°.
Water	0.08496	0.0959
Alcohol (Sp. Gr. 0.8092 = 95%)	0.0065	0.0089

EQUILIBRIUM IN THE SYSTEM CALCIUM OXIDE-CITRIC ACID-WATER AT 30°.  
(van Itallie, 1908.)

The compositions of the solid phases were determined by the "Rest Method" of Schreinemakers (1903). The results are presented in the triangular diagram and it was necessary to select the fictitious compound  $\text{C}_6\text{H}_5\text{O}_7 \cdot 1\frac{1}{2}\text{H}_2\text{O}$  instead of  $\text{C}_6\text{H}_5\text{O}_7$  in order to keep the citrate component within the limits of the diagram. This is in harmony with the choice of anhydrides as components in the inorganic oxy acid systems.

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{C}_6\text{H}_5\text{O}_7 \cdot 1\frac{1}{2}\text{H}_2\text{O}$	CaO.		$\text{C}_6\text{H}_5\text{O}_7 \cdot 1\frac{1}{2}\text{H}_2\text{O}$	CaO.	
55.86	0	$\text{C}_6\text{H}_5\text{O}_7 \cdot \text{H}_2\text{O}$	20.3	0.35	$\text{C}_6\text{H}_5\text{O}_7 \cdot \text{Ca}_4\text{H}_2\text{O}$
54.8	0.24	"	16.3	0.33	"
55.4	0.35	" + $(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot \text{Ca}_3\text{H}_4\text{O}$	12.5	0.39	"
53.7	0.40	$(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot \text{Ca}_3\text{H}_4\text{O}$	8.3	0.28	"
48.3	0.52	"	5.2	0.25	"
42.6	0.60	"	4.1	0.20	Quadruple pt.
38.5	0.77	"	3.2	0.20	...
36.5	0.70	" + $\text{C}_6\text{H}_5\text{O}_7 \cdot \text{Ca}_4\text{H}_2\text{O}$	2.4-0	0.21-0.13	Hydrate of $(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot \text{Ca}_4\text{H}_2\text{O}$
34.8	0.77	$\text{C}_6\text{H}_5\text{O}_7 \cdot \text{Ca}_4\text{H}_2\text{O}$	0.18	0.24	Quadruple pt.
27.5	0.45	"	0	0.113	$\text{Ca}(\text{OH})_2$

## CALCIUM Potassium FERROCYANIDE $\text{CaK}_3\text{Fe}(\text{CN})_6 \cdot 3\text{H}_2\text{O}$ .

100 parts  $\text{H}_2\text{O}$  dissolve 0.125 part salt at 15°, and 0.69 part at boiling-point.  
(Kunheim and Zimmerman, 1884.)  
100 gms.  $\text{H}_2\text{O}$  dissolve 0.41 gm.  $\text{CaK}_3\text{Fe}(\text{CN})_6$  at 15-17°.  
(Brown, 1907.)



**CALCIUM FLUORIDE**  $\text{CaF}_2$ .

One liter sat. aqueous solution contains 0.016 gm.  $\text{CaF}_2$  at  $18^\circ$  and 0.017 g. at  $26^\circ$ .

One liter sat. aqueous solution contains 0.0131 gm. fluor spar at  $0^\circ$ , 0.0149 gm. at  $15^\circ$ , 0.0159 gm. at  $25^\circ$  and 0.0167 gm. at  $40^\circ$ . (Kohlrausch, 1904-05, 1908.)

Freezing-point data for mixtures of calcium fluoride and calcium iodide are given by Ruff and Plato (1903) and for mixtures of calcium fluoride and calcium nitrate by Karandeeff (1910).

**CALCIUM FORMATE**  $\text{Ca}(\text{HCOO})_2$ .

## SOLUBILITY IN WATER.

(Lumsden, 1902; see also Krasnicki, 1887.)

t°.	Gms. $\text{Ca}(\text{HCOO})_2$ per 100 Gms.		t°.	Gms. $\text{Ca}(\text{HCOO})_2$ per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	16.15	13.90	60	17.50	14.89
20	16.60	14.22	80	17.95	15.22
40	17.05	14.56	100	18.40	15.53

Results in good agreement with the above are given by Stanley (1904).

**CALCIUM GLYCEROPHOSPHATES**  $\alpha = \text{OH} \cdot \text{CH}_2 \cdot \text{CH}(\text{OH}) \cdot \text{CH}_2 \cdot \text{OPO}_3\text{Ca}$ ,  
 $\beta = \text{OH} \cdot \text{CH}_2 \cdot \text{CH} \cdot \text{OPO}_3\text{Ca} \cdot \text{CH}_2 \cdot \text{OH}$ .SOLUBILITY OF CALCIUM  $\alpha$  GLYCEROPHOSPHATE IN WATER.

(Power and Tutin, 1905; Couch, 1917.)

t°.	Gms. $\text{CaCaH}_7\text{O}_8\text{P}$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{CaCaH}_7\text{O}_8\text{P}$ per 100 Gms. Sat. Sol.
0	5	40	3.5
10	4.6	60	2.7
20	5.2	80	1.8
25	5	100	0.9

Results varying from 1.7 to 5.4 gms. per 100 gms. sat. solution at or near  $18^\circ$  are given by Rogier and Fiore (1913), Willstaetter (1904) and King and Pyman (1914). It is pointed out by Couch, however, that since the solubilities of the  $\alpha$  and  $\beta$  isomer differ, and also that the commercial product contains both isomers, variable results will be obtained, depending on the composition of the product and the method used for determining the solubility. These authors also show that increasing amounts of alcohol in the solvent decrease the solubility of calcium glycerophosphate.

100 grams  $\text{H}_2\text{O}$  dissolve 1.66 grams calcium  $\beta$  glycerophosphate at  $20^\circ$ . (Couch, 1917.)

The results of King and Pyman (1914) are: 1.4 gms. at  $13^\circ$  and 1 gm. at  $15^\circ$ .

**CALCIUM HEPTOATE** (Oenanthane)  $\text{Ca}[\text{CH}_2(\text{CH}_2)_5\text{COO}]_2 \cdot \text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Lumsden, 1902; see also Landau, 1893; Altschul, 1896.)

t°.	0°.	20°.	40°.	60°.	80°.	100°.
Gm. $\text{Ca}(\text{C}_7\text{H}_{15}\text{O}_2)_2$ per 100 gms. solution	0.94	0.85	0.81	0.81	0.97	1.24

**CALCIUM HYDROXIDE**  $\text{Ca}(\text{OH})_2$ .

Recent determinations of the solubility of calcium hydroxide in water, agreeing fairly well with the average results given in the table on next page, are given by Bassett, Jr. (1908), Moody and Leyson (1908), Chugaev and Khlopina (1914) and Schwanow (1914).

One liter sat. aqueous solution contains 0.305 gm.  $\text{CaO}$  at  $120^\circ$ , 0.169 gm. at  $150^\circ$  and 0.084 gm. at  $190^\circ$ . (Herold, 1905.)

One liter of aqueous 5.2%  $\text{NH}_3$  solution dissolves 0.81 gm.  $\text{Ca}(\text{OH})_2$  at about  $10^\circ$ . (Konowalow, 1899b.)



# CALCIUM HYDROXIDE

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## CALCIUM HYDROXIDE $\text{Ca}(\text{OH})_2$

### SOLUBILITY IN WATER.

(Average curve from the results of Lamy, 1878; Maben, 1883-84; Herzfeld, 1897, and Guthrie, 1902)

t°.	Grams per 100 Grams $\text{H}_2\text{O}$ .		t°.	Grams per 100 Grams $\text{H}_2\text{O}$ .	
	$\text{Ca}(\text{OH})_2$ .	$\text{CaO}$ .		$\text{Ca}(\text{OH})_2$ .	$\text{CaO}$ .
0	0.185	0.140	50	0.128	0.097
10	0.176	0.133	60	0.116	0.088
20	0.165	0.125	70	0.106	0.080
25	0.159	0.120	80	0.094	0.071
30	0.153	0.116	90	0.085	0.064
40	0.141	0.107	100	0.077	0.058

### SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE AT 25°.

(Noyes and Chapin — Z. physik. Chem. 28, 520, '99.)

Millimols per Liter.		Grams per Liter of Saturated Solution.		
$\text{NH}_4\text{Cl}$ .	$\text{Ca}(\text{OH})_2$ .	$\text{NH}_4\text{Cl}$ .	$\text{Ca}(\text{OH})_2$ .	$\text{CaO}$ .
0.00	20.22	0.00	1.50	1.13
21.76	29.08	1.165	2.16	1.63
43.52	39.23	2.330	2.91	2.20
83.07	59.68	4.447	4.42	3.45

### SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF CALCIUM CHLORIDE.

(Zahoraky — Z. anorg. Chem. 3, 41, '93; Lunge — J. Soc. Chem. Ind. 11, 882, '92.)

Concentration of $\text{CaCl}_2$ Solutions, Wt. %.	Grams $\text{CaO}$ Dissolved per 100 cc. Solvent at:				
	20°.	40°.	60°.	80°.	100°.
0	0.1374	0.1162	0.1026	0.0845	0.0664
5	0.1370	0.1160	0.1020	0.0936	0.0906
10	0.1661	0.1419	0.1313	0.1328	0.1389
15	0.1993	0.1781	0.1706	0.1736	0.1842
20	0.1857*	0.2249	0.2204	0.2295	0.2325
25	0.1661*	0.3020*	0.2989	0.3261	0.3710
30	0.1630*	0.3680*	0.3664	0.4122	0.4922

\* Indicates cases in which a precipitate of calcium oxychloride separated and thus removed some of the  $\text{CaCl}_2$  from solution.

The results in 0%  $\text{CaCl}_2$  solutions, i.e., in pure water, are high when compared with the average results given above.

### SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF CALCIUM CHLORIDE AT 25°.

(Schreinemakers and Fiege, 1911.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{CaCl}_2$ .	$\text{CaO}$ .		$\text{CaCl}_2$ .	$\text{CaO}$ .	
5.02	0.101	$\text{Ca}(\text{OH})_2$	33.21	0.245	$\text{CaCl}_2 \cdot 4\text{CaO} \cdot 14\text{H}_2\text{O}$
10	0.115	"	33.72	0.254	" + $\text{CaCl}_2 \cdot \text{CaO} \cdot 2\text{H}_2\text{O}$
15.14	0.140	"	34.36	0.173	$\text{CaCl}_2 \cdot \text{CaO} \cdot 2\text{H}_2\text{O}$
18.15	0.148	" + $\text{CaCl}_2 \cdot 4\text{CaO} \cdot 14\text{H}_2\text{O}$	38.61	0.060	"
18.01	0.152	$\text{CaCl}_2 \cdot 4\text{CaO} \cdot 14\text{H}_2\text{O}$	41.32	0.048	"
21.02	0.147	"	44.30	0.030	"
28.37	0.170	"	44.61	0.029	" + $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$
32.67	0.225	$\text{Ca}(\text{OH})_2$ ?	44.77	...	$\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$

Data for the above system at 10°, 25°, 40°, 45°, 48°, and 50° are given in Milikau (1916).

Data for the solubility of calcium hydroxide in aqueous calcium iodide solutions at 25° are also given by Milikau.



**SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF CALCIUM NITRATE AT 25° AND AT 100°.**

(Bassett and Taylor, 1914; see also Cameron and Robinson, 1907a.)

Results at 25°.			Results at 100°.			Results at 100° (Con.).		
Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
CaO.	Ca(NO <sub>3</sub> ) <sub>2</sub> .		CaO.	Ca(NO <sub>3</sub> ) <sub>2</sub> .		CaO.	Ca(NO <sub>3</sub> ) <sub>2</sub> .	
0.1150	0	Ca(OH) <sub>2</sub>	0.0561	0	Ca(OH) <sub>2</sub>	1.576	58.67	Ca <sub>2</sub> N <sub>2</sub> O <sub>7</sub> ·2H <sub>2</sub> O
0.0978	4.836	"	0.0550	2.42	"	1.348	60.44	"
0.1074	9.36	"	0.0624	4.91	"	1.167	62.82	"
0.1193	13.77	"	0.1110	15.39	"	1.077	66.44	"
0.1444	22.46	"	0.1200	16.10	"	1.141	69.12	"
0.1650	27.83	"	0.155	21.86	"			
0.1931	32.94	"	0.269	33.03	"	1.252	70.60	" + a very little Ca-N <sub>2</sub> O <sub>7</sub> ·H <sub>2</sub> O
0.2579	40.66	"	0.480	42.26	"			
0.3060	44.44	"	0.973	50.94	"	1.203	70.40	Ca <sub>2</sub> N <sub>2</sub> O <sub>7</sub> ·H <sub>2</sub> O
0.2802	45.28	Ca <sub>2</sub> N <sub>2</sub> O <sub>7</sub> ·3H <sub>2</sub> O	1.261	53.75	"	1.103	71.44	"
0.2314	47.79	"	1.477	55.40	"	0.937	73.85	"
0.1894	51.07	"	1.476	55.43	"	0.849	75.74	"
0.1659	53.20	"	1.491	55.65	"	0.815	76.94	"
0.1486	55.25	"	1.635	56.89	" + Ca <sub>2</sub> N <sub>2</sub> O <sub>7</sub> ·2H <sub>2</sub> O	0.804	77.62	Ca(NO <sub>3</sub> ) <sub>2</sub>
0.0836	57.72	Ca(NO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	1.686	57.03		0.412	77.74	"
0	57.98	"	1.596	57.91	Ca <sub>2</sub> N <sub>2</sub> O <sub>7</sub> ·2H <sub>2</sub> O	0	78.43	"

Ceresine wax bottles were used and more than 6 months constant agitation allowed for attainment of equilibrium at 25° and 4-14 days at 100°.

**SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF CALCIUM SULFATE AT 25°.**

(Cameron and Bell, 1906.)

Gms. per 100 cc. Sat. Sol.		Solid Phase.	Gms. per 100 cc. Sat. Sol.		Solid Phase.
CaSO <sub>4</sub> .	CaO.		CaSO <sub>4</sub> .	CaO.	
0	0.1166	Ca(OH) <sub>2</sub>	0.1634	0.0939	CaSO <sub>4</sub> ·2H <sub>2</sub> O
0.0391	0.1141	"	0.1722	0.0611	"
0.0666	0.1150	"	0.1853	0.0349	"
0.0955	0.1215	"	0.1918	0.0176	"
0.1214	0.1242	"	0.2030	0.0062	"
0.1588	0.1222	" + CaSO <sub>4</sub> ·2H <sub>2</sub> O	0.2126	0	"

The mixtures were constantly agitated at 25° for two weeks.

**SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE AND OF SODIUM CHLORIDE.**

(Cabot, 1897.)

In KCl Solutions.				In NaCl Solutions.			
Gms. of the Chloride per Liter.	Gms. CaO per Liter at:			Gms. CaO per Liter at:			
	0°.	15°.	99°.	0°.	15°.	99°.	
0	1.36	1.31	0.635	1.36	1.31	0.635	
30	1.701	1.658	0.788	1.813	1.703	0.969	
60	1.725	1.674	0.876	...	1.824	1.004	
120	1.718	1.606	0.894	1.86	1.722	1.015	
240	1.248	1.199	0.617	1.37	1.274	0.771	
320	...	...	...	1.054	0.929	0.583	

Results in harmony with the above for the solubility of calcium hydroxide in aqueous solutions of potassium chloride at 50°, are given by Kernot, d'Agostino and Pellegrino (1908).



# CALCIUM HYDROXIDE

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## SOLUBILITY OF LIME IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE ALONE AND CONTAINING SODIUM HYDROXIDE.

(Maigret, 1905.)

G. NaCl per Liter.	Gms. CaO per Liter of Solution.			G. NaCl. per Liter.	Gms. CaO per Liter of Solution.		
	Without NaOH.	0.89 NaOH per Liter.	4.09 NaOH per Liter.		Without NaOH.	0.89 NaOH per Liter.	4.09 NaOH per Liter.
0	1.3	0.8	0.22	150	1.65	1.25	0.44
5	1.4	0.9	...	175	1.6	1.2	...
10	1.6	1.0	...	182	1.6	1.2	...
25	1.7	1.1	...	225	1.4	1.0	...
50	1.8	1.25	...	250	1.3	0.9	...
75	1.9	1.4	0.55	300	1.1	0.7	0.22
100	1.85	1.4	...	...	...	...	...

## SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF SODIUM HYDROXIDE.

(d'Anselme — Bull. soc. chim. [3] 29, 938, '03.)

Concentration of NaOH:		Grams CaO per Liter Sat. Solution at:			
Normality.	Gms. per Liter	20°.	50°.	70°.	100°.
0	0	1.170	0.880	0.75	0.54
N/100	0.4	0.94	0.65	0.53	0.35
N/25	1.6	0.57	0.35	0.225	0.14
N/15	2.66	0.39	0.20	0.11	0.05
N/8	5.00	0.18	0.06	0.04	0.01
N/5	8.00	0.11	0.02	0.01	trace
N/2	20.00	0.02	trace	0.00	0.00

For results upon mixtures of calcium hydroxide and alkali carbonates and hydroxides, see Bodländer — Z. angew. Chem. 18, 1138, '05.

## SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF GLYCEROL AT 25°.

(Herz and Knoch — Z. anorg. Chem. 46, 103, '05; for older determinations, see Berthelot — Ann. chim. phys. [3] 46, 176; and Caries — Arch. Pharm. [3] 4, 558, '74.)

Density of Solutions	Wt. per cent Glycerine in Solution.	Millimols $\frac{1}{2}$ Ca(OH) <sub>2</sub> per 100 cc. Solution.	Gms. per 100 cc. Solution.	
			Ca(OH) <sub>2</sub>	CaO.
1.0003	0.0	4.3	0.1593	0.1206
1.0244	7.15	8.13	0.3013	0.2281
1.0537	20.44	14.9	0.5522	0.4180
1.0842	31.55	22.5	0.8339	0.6313
1.1137	40.95	40.1	1.486	1.125
1.1356	48.7	44.0	1.631	1.234
1.2072	69.2	95.8	3.550	2.687

Data for the solubility of calcium hydroxide in aqueous solutions of phenol at 25° are given by van Meurs (1916).



**SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF GLYCEROL  
AND OF CANE SUGAR AT 25°.**

(Cameron and Patten, 1911.)

In order to obviate the uncertainties due to the presence of a large excess of the solid phase in contact with the solutions, the clear liquids, saturated at 0°, were decanted from the solid and slowly brought to 25° and constantly agitated at this temperature, until equilibrium with the finely divided solid phase, which separates at the higher temperature, was reached.

**Results for Glycerol Solutions.**

$d_4$ of Sat. Sol.	Gms. per 100 Ca(OH) <sub>2</sub>	Gms. Sat. Sol. C <sub>12</sub> H <sub>22</sub> (OH) <sub>11</sub>	Solid Phase.
0.983	0.117	0	Ca(OH) <sub>2</sub>
1.008	0.178	3.50	"
...	0.413	15.59	"
1.042	0.48	17.84	"
1.088	0.88	34.32	"
1.149	1.34	55.04	"

**Results for Sugar Solutions.**

$d_4$ of Sat. Sol.	Gms. per 100 Ca(OH) <sub>2</sub>	Gms. Sat. Sol. C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	Solid Phase.
I	0.188	0.62	Ca(OH) <sub>2</sub> + Sugar
I.021	0.730	4.82	"
I.037	1.355	7.50	"
I.067	3.21	11.90	"
I.109	5.38	17.42	"
I.123	6.07	19.86	"

**SOLUBILITY OF CALCIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF CANE SUGAR  
AT 80°.**

(von Ginneken, 1911.)

Gms. per 100 CaO.	Gms. Sat. Sol. Sugar.	Solid Phase.	Gms. per 100 CaO.	Gms. Sat. Sol. Sugar.	Solid Phase.
0.117	4.90	Ca(OH) <sub>2</sub>	0.358	19.50	Ca(OH) <sub>2</sub>
0.189	9.90	"	0.548	24.60	"
0.230	14.75	"	1.017	29.70	"

**SOLUBILITY OF LIME IN AQUEOUS SOLUTIONS OF SUGAR.**

(Weisberg — Bull. soc. chim. [3] 21, 775, '99.)

The original results were plotted on cross-section paper and the following table constructed from the curves.

**1st series,  $t^{\circ} = 16'-17^{\circ}$ .**

Gms. per 100 Solution. Sugar.	Gms. per 100 CaO.	G. CaO per 100 Gms. Sugar in Sol.
1	0.30	35.0
2	0.56	28.7
3	0.85	28.0
4	1.12	27.7
5	1.40	27.5
6	1.65	27.5
8	2.22	27.5
10	2.77	27.5
12	3.27	27.5
14	3.85	27.5

**2d, series  $t^{\circ} = 15^{\circ}$ .**

Gms. per 100 Solution. Sugar.	Gms. per 100 CaO.	G. CaO per 100 Gms. Sugar in Sol.
1	0.50	62.5
2	0.75	36.0
3	1.02	32.5
4	1.22	30.2
5	1.45	28.5
6	1.67	27.7
8	2.22	27.5
10	2.77	27.5
12	3.27	27.5
14	3.85	27.5

In the second series a very much larger excess of lime was used than in the first series. The author gives results in a subsequent paper, — Bull. soc. chim. [3] 23, 740, '00, — which show that the solubility is also affected by the condition of the calcium compound used, *i.e.*, whether the oxide, hydrate, or milk of lime is added to the sugar solutions.

A very exhaustive investigation of the factors which influence the solubility of lime in sugar solutions is described by Claassen (1911).



**CALCIUM IODATE**

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**CALCIUM IODATE**  $\text{Ca}(\text{IO}_3)_2 \cdot 6\text{H}_2\text{O}$ .**SOLUBILITY IN WATER.**

(Mylius and Funk — Ber. 30, 1724, '97; W. Abb. p. t. Reichenstalt 3, 448, '00.)

t°.	Gms. $\text{Ca}(\text{IO}_3)_2$ per 100 Gms. Sol.	Mols. $\text{Ca}(\text{IO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Ca}(\text{IO}_3)_2$ per 100 Gms. Sol.	Mols. $\text{Ca}(\text{IO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
0	0.10	0.0044	$\text{Ca}(\text{IO}_3)_2 \cdot 6\text{H}_2\text{O}$	21	0.37	0.016	$\text{Ca}(\text{IO}_3)_2 \cdot \text{H}_2\text{O}$
10	0.17	0.0075	"	35	0.48	0.021	"
18	0.25	0.011	"	40	0.52	0.023	"
30	0.42	0.019	"	45	0.54	0.024	"
40	0.61	0.027	"	50	0.59	0.026	"
50	0.89	0.040	"	60	0.65	0.029	"
54	1.04	0.046	"	80	0.79	0.034	"
60	1.36	0.063	"	100	0.94	0.042	"

Density of solution saturated at 18° = 1.00.

**CALCIUM IODIDE**  $\text{CaI}_2$ .**SOLUBILITY IN WATER.**

(Average curve from the results of Kremers — Pogg. Ann. 103, 65, '58; Etard — Ann. chim. phys. [5] 2, 532, '94.)

t°.	Gms. $\text{CaI}_2$ per 100 Gms. Solution.	t°.	Gms. $\text{CaI}_2$ per 100 Gms. Solution.	t°.	Gms. $\text{CaI}_2$ per 100 Gms. Solution.
0	64.6	30	69	80	78
10	66.0	40	70.8	100	81
20	67.6	60	74		

Density of solution saturated at 20° = 2.125.

The fusion-point curve (solubility, see footnote, p. 1) is given for mixtures of calcium iodide and iodine by Olivari (1908).

**CALCIUM IODO MERCURATE.**A saturated solution of  $\text{CaI}_2$  and  $\text{HgI}_2$  in water at 15.9° was found by Duboin (1906) to have the composition  $\text{CaI}_2 \cdot 1.3\text{HgI}_2 \cdot 12.3\text{H}_2\text{O}$ ;  $d = 2.89$  and the solid phase in contact with the solution was  $\text{CaI}_2 \cdot \text{HgI}_2 \cdot 8\text{H}_2\text{O}$ .**CALCIUM PerIODIDE**  $\text{CaI}_4$ .

Data for the formation of calcium periodide in aqueous solution at 25° are given by Herz and Bulla (1911). (See reference note under calcium perbromide, p. 189.)

**CALCIUM LACTATE**  $\text{Ca}(\text{C}_6\text{H}_7\text{O}_6)_2 \cdot 5\text{H}_2\text{O}$ .100 gms.  $\text{H}_2\text{O}$  dissolve 3.1 gms. of the salt at 0°, 5.4 gms. at 15° and 7.9 gms. at 30°. (Hill and Cocking, 1912.)**CALCIUM MALATE**  $\text{CaC}_4\text{H}_4\text{O}_6 \cdot \text{H}_2\text{O}$ .**SOLUBILITY OF CALCIUM MALATE IN WATER AND IN ALCOHOL.**

(Partheil and Hübnér, 1903.)

100 gms.  $\text{H}_2\text{O}$  dissolve 0.9214 gm.  $\text{CaC}_4\text{H}_4\text{O}_6 \cdot \text{H}_2\text{O}$  at 18°, and 0.8552 gm. at 25°.100 gms. 95% alcohol dissolve 0.0049 gm.  $\text{CaC}_4\text{H}_4\text{O}_6 \cdot \text{H}_2\text{O}$  at 18°, and 0.00586 gm. at 25°.



**CALCIUM (Neutral) MALATE**  $\text{Ca}(\text{C}_4\text{H}_4\text{O}_6)_2 \cdot 3\text{H}_2\text{O}$ .

**CALCIUM (Acid) MALATE**  $\text{Ca}(\text{C}_4\text{H}_3\text{O}_6)_2 \cdot 6\text{H}_2\text{O}$ .

**CALCIUM MALONATE**  $\text{Ca}(\text{C}_3\text{H}_2\text{O}_4)_2 \cdot 4\text{H}_2\text{O}$ .

SOLUBILITY OF EACH IN WATER.

(Twigg and Hecht, 1886; Cantoni and Basadonna, 1906; the malonate, Miczynski, 1886.)

°F.	Ca. Neutral Malate.			Ca. Acid Malate.		Ca. Malonate.
	Gms. $\text{Ca}(\text{C}_4\text{H}_4\text{O}_6)_2$ per 100			Gms. $\text{Ca}(\text{C}_4\text{H}_3\text{O}_6)_2$ per 100 Gms.		Gms. $\text{Ca}(\text{C}_3\text{H}_2\text{O}_4)_2$ per 100 Gms. $\text{H}_2\text{O}$ .
	Gms. $\text{H}_2\text{O}$ .	Gms. Sol.	cc. Sol. (C and B).	Water.	Solution.	
0	...	...	...	...	...	0.290 (0.374)
10	0.85	0.84	...	1.8	1.77	0.330 (0.419)
20	0.82	0.81	0.907	1.5	1.48	0.365 (0.460)
30	0.78	0.77	0.837	2	1.96	0.396 (0.495)
40	0.74	0.73	0.816	5.2	4.94	0.422 (0.524)
50	0.66	0.65	0.809	15	13.09	0.443 (0.544)
57	0.57	0.56	...	32.24	24.29	...
60	0.58	0.58	0.804	26	20.64	0.460
70	0.63	0.63	0.795	11	9.91	0.472
80	0.71	0.70	0.754	6.8	6.37	0.479
90	...	...	0.740			

The results for calcium malonate given above in parentheses are by Cantoni and Diotallevi (1905), but these authors fail to state the terms in which their data are reported. By comparison with other papers of the series, it is probable that in this case the figures refer to grams per 100 cc. saturated solution.

**CALCIUM NITRATE**  $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ .

SOLUBILITY IN WATER.

(Bassett and Taylor, 1912.)

(Silica vessels used. Constant agitation at constant temperature for two to three days. Calcium determined by precipitation as oxalate and weighing as oxide.)

t°.	Gms. $\text{Ca}(\text{NO}_3)_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{Ca}(\text{NO}_3)_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{Ca}(\text{NO}_3)_2$ per 100 Gms. Sat. Sol.	Solid Phase.
-0.4	1.4	Ice	10	53.55	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	45	71.45	$\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$
-1.4	4.78	"	15	54.94	"	50	73.79	"
-1.9	6.53	"	20	56.39	"	51	74.73	"
-3.05	10	"	25	57.98	"	51.1	...	"
-4.15	12.98	"	30	60.41	"	49	77.49	$\text{Ca}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$
-15.7	33.13	"	35	62.88	"	51	78.05	"
-21.7	38.7	"	40	66.21	"	55	78.16	$\text{Ca}(\text{NO}_3)_2$
-28.7	...	"	42.4	68.68	"	80	78.2	"
-26.7	43.37	$\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	42.4	68.74	"	100	78.43	"
-10	47.31	"	42.7	...	"	125	78.57	"
0	50.50	"	42.45	71.7	"	147.5	78.8	"
5	51.97	"	40	70.37	$\text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$	151	79	"

† m. pt.

\* Eutectic.

SOLUBILITY OF THE UNSTABLE CALCIUM NITRATE TETRAHYDRATE  $\beta$  IN WATER.

(Results supplementary to the above.)

(Taylor and Henderson, 1915.)

t°.	Gms. $\text{Ca}(\text{NO}_3)_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{Ca}(\text{NO}_3)_2$ per 100 Gms. Sat. Sol.	Solid Phase.
0	50.17	$\alpha\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	38	66.65	$\beta\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$
22.2	56.88	"	39	67.93	"
25	57.90	"	39.6 (m. pt.)	69.50	"
30	60.16	"	39 (reflex pt.)	75.34	"
30	61.57	$\beta\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	40	66.22	$\alpha\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$
34	63.66	"	42.7 (m. pt.)	69.50	"
35	62.88	$\alpha\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	42.4 (reflex pt.)	71.70	"
38	64.34	"	25	77.30	$\text{Ca}(\text{NO}_3)_2$



SOLUBILITY OF CALCIUM NITRATE IN AQUEOUS SOLUTIONS OF CALCIUM  
THIOSULFATE AT 9° AND AT 25° AND VICE VERSA.

(Kremann and Rodemund, 1914.)

Results at 9°.			Results at 25°.		
Gms. per 100	Gms. Sat. Sol.	Solid Phase.	Gms. per 100	Gms. Sat. Sol.	Solid Phase.
Ca(NO <sub>3</sub> ) <sub>2</sub> .	CaS <sub>2</sub> O <sub>3</sub> .		Ca(NO <sub>3</sub> ) <sub>2</sub> .	CaS <sub>2</sub> O <sub>3</sub> .	
46.02	5.46	Ca(NO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	54.03	4.27	Ca(NO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O
45.68	6.81	" + CaS <sub>2</sub> O <sub>3</sub> ·6H <sub>2</sub> O	50.25	9.10	"
27.92	10.46	CaS <sub>2</sub> O <sub>3</sub> ·6H <sub>2</sub> O	45.92	13	" + CaS <sub>2</sub> O <sub>3</sub> ·6H <sub>2</sub> O
10.49	22.81	"	42.93	13.83	CaS <sub>2</sub> O <sub>3</sub> ·6H <sub>2</sub> O
...	29.33	"	32.01	17.09	"
			19.51	23.78	"
			8.15	29.85	"

SOLUBILITY OF CALCIUM NITRATE IN AQUEOUS SOLUTIONS OF SODIUM  
NITRATE AT 9° AND AT 25° AND VICE VERSA.

(Kremann and Rodemund, 1914.)

Results at 9°.			Results at 25°.		
Gms. per 100	Gms. Sat. Sol.	Solid Phase.	Gms. per 100	Gms. Sat. Sol.	Solid Phase.
Ca(NO <sub>3</sub> ) <sub>2</sub> .	NaNO <sub>3</sub> .		Ca(NO <sub>3</sub> ) <sub>2</sub> .	NaNO <sub>3</sub> .	
47.51	9.51	Ca(NO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	54.58	7.25	Ca(NO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O
46.08	12.56	" + NaNO <sub>3</sub>	53.22	10.70	"
26.67	23.32	NaNO <sub>3</sub>	52.73	12.08	" + NaNO <sub>3</sub>
11.76	34.26	"	52.40	11.88	NaNO <sub>3</sub>
			37.31	19.48	"
			26.91	24.98	"
			14.61	36.12	"

These authors also give the complete solubility relations of the reciprocal salt pairs,  $\text{Ca(NO}_3)_2 + \text{Na}_2\text{S}_2\text{O}_3 \rightleftharpoons 2\text{NaNO}_3 + \text{CaS}_2\text{O}_3$  at 9° and 25°.

SOLUBILITY OF CALCIUM NITRATE IN AQUEOUS SOLUTIONS OF NITRIC ACID AT 2

(Bassett and Taylor, 1912.)

(The mixtures were shaken intermittently, by hand, during quite long period one week was allowed between duplicate determinations.)

Gms. per 100	Gms. Sat. Sol.	Solid Phase.	Gms. per 100	Gms. Sat. Sol.	Solid Phase.	Gms. per 100	Gms. Sat. Sol.	Solid Phase.
Ca(NO <sub>3</sub> ) <sub>2</sub> .	HNO <sub>3</sub> .		Ca(NO <sub>3</sub> ) <sub>2</sub> .	HNO <sub>3</sub> .		Ca(NO <sub>3</sub> ) <sub>2</sub> .	HNO <sub>3</sub> .	
57.98	0	Ca(NO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	32.84	32.63	Ca(NO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	9.34	65.69	Ca(NO <sub>3</sub> ) <sub>2</sub> ·2H <sub>2</sub> O
54.82	3.33	"	32.50	33.52	"	8.52	67.20	"
52.06	5.87	"	33.44	35.63	Ca(NO <sub>3</sub> ) <sub>2</sub> ·3H <sub>2</sub> O	5.06	71.12	Ca(NO <sub>3</sub> ) <sub>2</sub>
51.58	7.21	"	20.05	41.66	"	2.53	74.77	"
47.82	11.27	"	27.79	45.70	"	1.05	78.56	"
45.50	13.71	"	31.09	40.56	Ca(NO <sub>3</sub> ) <sub>2</sub> ·2H <sub>2</sub> O	0.54	80.83	"
40.70	19.65	"	26.07	45.70	"	0.36	85.83	"
38.17	22.80	"	17.41	55.48	"	0.01	90.90	"
34.40	28.81	"	12.25	62.05	"	0	96.86	"

Freezing-point data for the Ternary System  $\text{Ca(NO}_3)_2 + \text{KNO}_3 + \text{NaNO}_3$  given by Menzies and Dutt, 1911.

SOLUBILITY OF CALCIUM NITRATE IN SEVERAL ORGANIC SOLVENTS.

Solvent.	t°.	Gms. Ca(NO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Sat. Solution.	Authority.
Methyl Alcohol	25	65.5	(D'Ans and Siegler, 1911)
Propyl "	25	36.5	" "
i Butyl "	25	25	" "
Amyl "	25	13.3	" "
Acetone	25	58.5	" "
Methyl Acetate	18	41	(d sat. sol. = 1.313) (Naumana, 1909.)



**SOLUBILITY OF CALCIUM NITRATE IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°. (D'Ans and Siegler, 1913.)**

Gms. per 100 C <sub>2</sub> H <sub>5</sub> OH.	Gms. Sat. Sol. Ca(NO <sub>3</sub> ) <sub>2</sub> .	Solid Phase.	Gms. per 100 C <sub>2</sub> H <sub>5</sub> OH.	Gms. Sat. Sol. Ca(NO <sub>3</sub> ) <sub>2</sub> .	Solid Phase.
0	57.5	Ca(NO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	15.2	69.52	Ca(NO <sub>3</sub> ) <sub>2</sub> unstable
8.1	55.2	"	20.4	66.08	" "
14.1	52.9	"	35.9	57.7	" "
22.3	50.2	"	41.8	51.4	" "
29.4	49	"	27.39	61.96	Ca(NO <sub>3</sub> ) <sub>2</sub> stable
31.2	52	"	28.5	61.15	"
29.5	56.2	"	29.6	60.3	" + Ca(NO <sub>3</sub> ) <sub>2</sub> ·2C <sub>2</sub> H <sub>5</sub> OH
27.8	60	"	60.2	38.6	Ca(NO <sub>3</sub> ) <sub>2</sub> ·2C <sub>2</sub> H <sub>5</sub> OH
26.5	62.3	" + Ca(NO <sub>3</sub> ) <sub>2</sub>	54.6	41.9	"
0	82.5	Ca(NO <sub>3</sub> ) <sub>2</sub> unstable	42.5	50.97	"
5.8	77	" "	35.8	55.3	"

**CALCIUM NITRITE Ca(NO<sub>2</sub>)<sub>2</sub>·4H<sub>2</sub>O.**

**SOLUBILITY IN WATER. (Oswald, 1914.)**

t°.	Gms. Ca(NO <sub>2</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. Ca(NO <sub>2</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-4	16.7	Ice	18.5	43	Ca(NO <sub>2</sub> ) <sub>2</sub> ·4H <sub>2</sub> O
-9.3	25.5	"	42	51.8	"
-12.5	29.5	"	44	53.5	" + Ca(NO <sub>2</sub> ) <sub>2</sub> ·2H <sub>2</sub> O
-14.5	32	"	54	55.2	Ca(NO <sub>2</sub> ) <sub>2</sub> ·2H <sub>2</sub> O
-17.5	35	" + Ca(NO <sub>2</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	64	58.4	"
-9.5	36.2	Ca(NO <sub>2</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	70	60.3	"
0	38.3	"	73	61.5	"
16	42.3 (d <sub>20</sub> = 1.4305)	"	91	71.2	"

An aqueous solution simultaneously saturated with calcium nitrite and silver nitrite, contains 92.4 gms. Ca(NO<sub>2</sub>)<sub>2</sub> + 11.2 gms. AgNO<sub>2</sub> per 100 gms. H<sub>2</sub>O at 14°. (Oswald, 1914.)

100 cc. sat. solution of calcium nitrite in 90 % alcohol contain 39 gms. Ca(NO<sub>2</sub>)<sub>2</sub>·H<sub>2</sub>O at 20°.

100 cc. sat. solution of calcium nitrite in absolute alcohol contain 1.1 gms. Ca(NO<sub>2</sub>)<sub>2</sub>·H<sub>2</sub>O at 20°. (Vogel, 1903.)

**CALCIUM OLEATE (C<sub>18</sub>H<sub>33</sub>O<sub>2</sub>)<sub>2</sub>Ca.**

One liter water dissolves about 0.1 gm. calcium oleate at t° not stated. (Fahrian, 1916.)

100 gms. glycerol (of d = 1.114) dissolve 1.18 gms. calcium oleate at t° not stated. (Asselin, 1873.)

**CALCIUM OXALATE Ca(COO)<sub>2</sub>·H<sub>2</sub>O.**

**SOLUBILITY IN WATER, BY ELECTROLYTIC CONDUCTIVITY METHOD. (Holleman, Kohlrausch, and Rose, 1893; Richards, McCaffrey, and Bisbee, 1901.)**

t°.	Gms. CaC <sub>2</sub> O <sub>4</sub> per Liter of Solution.	t°.	Gms. CaC <sub>2</sub> O <sub>4</sub> per Liter of Solution.
13	0.0067 (H)	25	0.0068 (R, McC and B)
28	0.0056 (K and R)	50	0.0095 "
24	0.0080 (H)	95	0.0140 "

**SOLUBILITY OF CALCIUM OXALATE IN AQUEOUS SOLUTIONS OF ACETIC ACID AT 26°-27°. (Herz and Muhs, 1903.)**

Normality of Acetic Acid.	G. CH <sub>3</sub> COOH per 100 cc. Sol.	Residue from 50.05g cc. Solution.
0	0.00	0.0017
0.58	3.48	0.0048
2.89	17.34	0.0058
5.79	34.74	0.0064

The residues were dried at 70° C.



**CALCIUM OXALATE**

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**SOLUBILITY OF CALCIUM OXALATE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 25°.**

(Henderson and Taylor, 1916.)

Normality of HCl.	Gms. $\text{CaC}_2\text{O}_4$ per Liter Sat. Sol.	Normality of HCl.	Gms. $\text{CaC}_2\text{O}_4$ per Liter Sat. Sol.
0	0.009	0.500	2.638
0.125	0.717	0.625	3.319
0.250	1.359	0.750	3.922
0.375	2.019	1	5.210

These authors also give data showing the effect of increasing amounts of  $\text{KNO}_3$  upon the solubility of calcium oxalate in 0.5 normal HCl at 25° also of the effect of increasing amounts of potassium trichloroacetic acid upon solubility in 0.5 normal trichloroacetic acid, and of increasing amounts of potassium monochloroacetic acid upon the solubility of calcium oxalate in 0.5 normal monochloroacetic acid.

**SOLUBILITY OF CALCIUM OXALATE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE AND OF SODIUM PHOSPHATE.**

(Gerard, 1901.)

Salt in Aq. Solution.	Gms. Salt per Liter.	t°.	Gms. $\text{CaC}_2\text{O}_4$ per Liter.	Salt in Aq. Solution.	Gms. Salt per Liter.	t°.	Gms. $\text{CaC}_2\text{O}_4$ per Liter.
NaCl	1	25	0.0075	NaCl	25	37	0.01
"	5	25	0.0188	$\text{Na}_2\text{H}(\text{PO}_4)_2$	4.8	15	0.01
"	10	25	0.0255	"	4.8	37	0.01
"	25	25	0.0291				

One liter 45% ethyl alcohol dissolves 0.000525 gm. calcium oxalate, temperature stated. (Guerin, 1901.)

**CALCIUM OXIDE  $\text{CaO}$ .**

100 gms. molten  $\text{CaCl}_2$  dissolve 16.2 gm.  $\text{CaO}$  at about 910°.

(Arndt and Loewenstein, 1915.)

Data for the systems,  $\text{CaO} + \text{MgO}$  and for  $\text{CaO} + \text{Al}_2\text{O}_3 + \text{MgO}$  are given Rankin and Merwin (1916); for  $\text{CaO} + \text{Al}_2\text{O}_3 + \text{SiO}_2$  by Rankin and Merwin (1915); for  $\text{CaO} + \text{Fe}_2\text{O}_3$  by Sosman and Merwin (1916); and for  $\text{CaO} + \text{SiO}_2$  by Bowen (1914).

Data for the system  $\text{CaO} + \text{C} + \text{CaC}_2 + \text{CO}$  are given by Thompson (1914).

**CALCIUM PHOSPHATE (Tribasic)  $\text{Ca}_3(\text{PO}_4)_2$ .****SOLUBILITY IN WATER.**

The determinations of the solubility of this salt in water, as stated in literature, are found to vary within rather wide limits, due, no doubt, to the fact that so-called tribasic calcium phosphate is apparently a solid solution of the dibasic salt and calcium oxide, and therefore analyses of individual samples may show an excess of either lime or phosphoric acid. When placed in contact with water, more  $\text{PO}_4$  ions enter solution than  $\text{Ca}$  ions, the resulting solution being acid in reaction and the solid phase richer in lime than it was, previous to being added to the water. For material having a composition approximately that represented by the formula  $\text{Ca}_3(\text{PO}_4)_2$ , the amount which is dissolved by  $\text{CO}_2$  free water at the ordinary temperature, as calculated from the calorimetric determination, is 0.01 to 0.10 gram per liter, depending upon the conditions of the experiment. Water saturated with  $\text{CO}_2$  dissolves 0.15 to 0.30 gram per liter.

A list of references to papers on this subject is given by Cameron and Hurst, *J. Am. Chem. Soc.*, **26**, 903, 1904; see also Cameron and Bell, *Ibid.*, **27**, 1512, 1905.



**CALCIUM PHOSPHATE (Dibasic)  $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$ .****SOLUBILITY IN WATER.**

(Cameron and Seidell — J. Am. Chem. Soc. 26, 1460, '04; see also Rindell — Compt. rend. 134, 112, '02; Magnanini — Gazz. chim. ital. 31, 11, 544, '01.)

1 liter of  $\text{CO}_2$  free water dissolves 0.136 gram  $\text{CaHPO}_4$  at  $25^\circ$ .

1 liter of water sat. with  $\text{CO}_2$  dissolves 0.561 gram  $\text{CaHPO}_4$  at  $25^\circ$ .

**SOLUBILITY OF DI CALCIUM PHOSPHATE AND OF MONO CALCIUM PHOSPHATE IN AQUEOUS SOLUTIONS OF PHOSPHORIC ACID AT  $25^\circ$ .**

(Cameron and Seidell — J. Am. Chem. Soc. 27, 1508, '05; Causse — Compt. rend. 114, 414, '92.)

Gms. per Liter of Solution.		Gms. per Liter Calc. from $\text{CaO}$ Found.		$\text{P}_2\text{O}_5$ per Liter in Excess of that combined with $\text{Ca}$ .		Solid Phase.
$\text{CaO}$ .	$\text{P}_2\text{O}_5$ .					
1.71	4.69	4.15	$\text{CaHPO}_4$	2.53	$\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$	
11.57	36.14	28.05	"	21.5	"	
23.31	75.95	56.53	"	46.45	"	
39.81	139.6	97.01	"	89.0	"	
49.76	191.0	120.7	"	128.0	"	
59.40	234.6	144.1	"	159.4	"	
70.31	279.7	170.6	"	190.7	"	
77.00	317.0	{ 174.2	$\text{CaHPO}_4$ or	226.0	$\text{CaHPO}_4 \cdot 2\text{H}_2\text{O} +$	
		{ 321.3	$\text{CaH}_2(\text{PO}_4)_2$	122.2	$\text{CaH}_2(\text{PO}_4)_2 \cdot \text{H}_2\text{O}$	
72.30	351.9	301.6	$\text{CaH}_2(\text{PO}_4)_2$	169.0	$\text{CaH}_2(\text{PO}_4)_2 \cdot \text{H}_2\text{O}$	
69.33	361.1	289.3	"	186.1	"	
59.98	419.7	250.2	"	267.9	"	
53.59	451.7	223.7	"	316.1	"	
44.52	505.8	185.8	"	393.1	"	
39.89	538.3	166.4	"	437.4	"	

Density of the solution in contact with both salts at  $25^\circ = 1.29$ .

**SOLUBILITY OF CALCIUM PHOSPHATES IN AQUEOUS SOLUTIONS OF PHOSPHORIC ACID AT DIFFERENT TEMPERATURES.**

(Bassett, Jr., 1908, 1917.)

Results at $25^\circ$ .			Results at $40^\circ$ .			Results at $50.7^\circ$ .		
Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{CaO}$ .	$\text{P}_2\text{O}_5$ .		$\text{CaO}$ .	$\text{P}_2\text{O}_5$ .		$\text{CaO}$ .	$\text{P}_2\text{O}_5$ .	
3.088	36.11	$\text{CaH}_2\text{P}_2\text{O}_7 \cdot \text{H}_2\text{O}$	1.768	42.42	$\text{CaH}_2\text{P}_2\text{O}_7 \cdot \text{H}_2\text{O}$	0.336	62.01	$\text{CaH}_2\text{P}_2\text{O}_7 +$
4.908	28.34	"	3.584	36.79	"	"	"	$\text{CaH}_2\text{P}_2\text{O}_7 \cdot \text{H}_2\text{O}$
5.809	24.20	" + $\text{CaHPO}_4$	5.755	27.25	" + $\text{CaHPO}_4$	0.635	58.08	$\text{CaH}_2\text{P}_2\text{O}_7 \cdot \text{H}_2\text{O}$
5.523	22.00	$\text{CaHPO}_4$	4.813	21.67	$\text{CaHPO}_4$	1.428	50.25	"
1.499	17.55	"	3.810	16.35	"	2.974	41.92	"
1.638	9.100	"	2.536	9.905	"	4.880	33.18	"
1.878	6.049	"	1.847	6.979	"	5.725	29.61	" + $\text{CaHPO}_4$
1.265	2.387	"	1.267	4.397	"	3.507	15.48	$\text{CaHPO}_4$
0.7	0.417	{ $\text{CaHPO}_4$	0.576	1.819	"	2.328	9.465	"
0.7	0.166	{ $\text{H}_2\text{O}$	0.156	0.426	"	1.563	6.157	"
0.7	0.140	"	0.0592	0.158	"	0.692	2.281	"
0.7	0.118	"	0.0508	0.128	$\text{Ca}_2\text{P}_2\text{O}_7 \cdot \text{H}_2\text{O}$	0.0596	0.1527	$\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$
0.7	0.093	"	0.0098	0.0262	"	0.0514	0.1331	$\text{Ca}_2\text{P}_2\text{O}_7 \cdot \text{H}_2\text{O}$
0.7	0.070	{ More basic than	0.0709	trace	$\text{Ca}_2\text{P}_2\text{O}_7 \cdot 4\text{H}_2\text{O}$	0.0351	0.0942	"
0.7	0.047	$\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$	0.0814	"	"	0.0106	0.0309	"
0.7	0.023	"	0.0840	"	"	0.0007	0.0007	"

In the case of most of the solutions 7-15 weeks constant agitation was allowed for attainment of equilibrium. For the last seven results at  $25^\circ$ , 18 months were required. Ceresine bottles were used in these cases. The solid phases were determined by analysis. The quintuple points were found by dilatometer experiments at  $36^\circ$ ,  $21^\circ$  and  $152^\circ$ . (See next page.)



# CALCIUM PHOSPHATES

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## SOLUBILITY OF CALCIUM PHOSPHATES IN AQUEOUS SOLUTIONS OF PHOSPHORIC ACID AT TEMPERATURES ABOVE 100°.

(Bassett, Jr., 1908.)

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	CaO.	P <sub>2</sub> O <sub>5</sub> .	
100	2.503	53.71	CaH <sub>2</sub> P <sub>2</sub> O <sub>7</sub> +CaH <sub>2</sub> P <sub>2</sub> O <sub>6</sub> H
115 b. pt.	5.623	43.60	CaH <sub>2</sub> P <sub>2</sub> O <sub>6</sub> H <sub>2</sub> O+CaHPC
132 "	4.327	53.43	CaH <sub>2</sub> P <sub>2</sub> O <sub>7</sub> +CaH <sub>2</sub> P <sub>2</sub> O <sub>6</sub> H <sub>2</sub>
169 "	4.489	63.95	CaH <sub>2</sub> P <sub>2</sub> O <sub>6</sub>

The quintuple points for the system determined by dilatometer experiments are as follows:

152	5.60	53.1	CaH <sub>2</sub> P <sub>2</sub> O <sub>7</sub> +CaH <sub>2</sub> P <sub>2</sub> O <sub>6</sub> H <sub>2</sub> O+Ca
21	5.81	23.5	CaH <sub>2</sub> P <sub>2</sub> O <sub>6</sub> H <sub>2</sub> O+CaHPO <sub>4</sub> +CaHP
36	0.0514	0.14	CaHPO <sub>4</sub> +CaHPO <sub>4</sub> .2H <sub>2</sub> O+Ca <sub>2</sub> P <sub>2</sub>

For additional data on the solubility of calcium phosphates in water, see Cameron and Bell, 1905 and 1910.

Data for the four component system, lime, phosphoric acid, sulfuric acid and water, the essential constituents of "superphosphates," are given by Cameron and Bell (1906).

One liter of aqueous 0.005 % potassium bitartrate solution saturated with phosphate, contains 0.08 gm. Ca and 0.181 gm. H<sub>3</sub>PO<sub>4</sub> at 25°. (Magnan)

## SOLUBILITY OF CALCIUM PHOSPHATE IN AQUEOUS SALT SOLUTIONS UNDER ATMOSPHERIC PRESSURE OF CO<sub>2</sub> AT 14°.

(Ehlert and Hempel, 1912.)

Salt in Aq. Solvent.	Gms. Salt per 100 Gms. H <sub>2</sub> O.	Gms. Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> per Liter Solvent.	Salt in Aq. Solution.	Gms. Salt per 100 Gms. H <sub>2</sub> O.
Water	...	0.228	MgSO <sub>4</sub> .K <sub>2</sub> SO <sub>4</sub> .MgCl <sub>2</sub> .6H <sub>2</sub> O	70.95
NH <sub>4</sub> Cl	45.74	1.371	"	conc.
"	conc.	1.293	K <sub>2</sub> SO <sub>4</sub>	74.5
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	56.5	2.413	"	conc.
"	conc.	5.885	NaCl	50
MgCl <sub>2</sub> .6H <sub>2</sub> O	86.9	1.287	"	conc.
"	conc.	2.892	NaNO <sub>3</sub>	72.7
MgSO <sub>4</sub> .7H <sub>2</sub> O	105.3	1.9728	"	conc.
"	conc.	3.6001	Na <sub>2</sub> SO <sub>4</sub> .10H <sub>2</sub> O	137.7
MgCl <sub>2</sub> .KCl.6H <sub>2</sub> O	79.2	1.577	"	conc.
"	conc.	1.154		

Data for the solubility of calcium phosphate in aqueous saturated solutions of carbon dioxide containing ammonia are given by Foster and Neville, 1911.

## CALCIUM PELARGONATE (Nonate) Ca[CH<sub>3</sub>(CH<sub>2</sub>)<sub>7</sub>COO]<sub>2</sub>.H<sub>2</sub>O.

## CALCIUM PROPIONATE Ca(CH<sub>3</sub>.CH<sub>2</sub>COO)<sub>2</sub>.H<sub>2</sub>O.

### SOLUBILITY OF EACH IN WATER.

(Lumsden, 1902; Krasnicki, 1887.)

Calcium Pelargonate.		Calcium Propionate.	
t°.	Gms. Ca[CH <sub>3</sub> (CH <sub>2</sub> ) <sub>7</sub> COO] <sub>2</sub> per 100 Gms. H <sub>2</sub> O.	Gms. Ca(CH <sub>3</sub> .CH <sub>2</sub> COO) <sub>2</sub> per 100 Gms.	
		Water.	Solution.
0	0.16	42.80	29.97
20	0.14	39.85	28.48
40	0.13	38.45	27.76
60	0.12	38.25	27.67
80	0.15	39.85	28.48
90	0.18	42.15	29.66
100	0.26	48.44	32.63



**CALCIUM SALICYLATE**  $\text{Ca}(\text{C}_6\text{H}_4\text{OHCOO})_2 \cdot 3\text{H}_2\text{O}$ .

100 grams of the saturated aqueous solution contain 2.29 grams of the anhydrous salt at 15° and 35.75 grams at 100°.

(Tarugi and Checchi, 1901.)

**CALCIUM SELENATE**  $\text{CaSeO}_4$ .

## SOLUBILITY IN WATER

(Etard — Ann. chim. phys. [7] 2, 532, '94.)

t°.	-1°.	+5°.	20°.	37°.	67°.
Gms. per 100 gms. sol.	7.4	7.3	7.6	6.8	5.1

The accuracy of these results appears questionable.

**CALCIUM SILICATE**  $\text{CaSiO}_3$ .

## SOLUBILITY IN WATER AND IN AQUEOUS SUGAR SOLUTIONS AT 17°.

(Weisberg — Bull. soc. chim. [3] 15, 1097, '96.)

The sample of calcium silicate was air dried.

Solvent.	Grams per 100 cc. Saturated Solution.			
	At 17°.		After Boiling and Filtering Hot.	
	CaO(det.)	CaSiO <sub>3</sub> (calc.)	CaO(det.)	CaSiO <sub>3</sub> (calc.)
Water	0.0046	0.0095	...	...
10% sugar sol.	0.0065	0.0135	0.0094	0.0195
20% sugar sol.	0.0076	0.0157	0.0120	0.0249

FREEZING-POINT DATA (Solubility, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES OF CALCIUM SILICATE AND OTHER COMPOUNDS.

$\text{CaSiO}_3 + \text{CaS}$	(Lebedew, 1911.)
" + $\text{CaTiO}_3$	(Smolenaky, 1911-12.)
" + $\text{Li}_2\text{SiO}_3$	(Wallace, 1909.)
" + $\text{MgSiO}_3$	(Allen and White, 1911; Ginsberg, 1906.)
" + $\text{MnSiO}_3$	(Ginsberg, 1908, 1909.)
" + $\text{Na}_2\text{SiO}_3$	(Wallace, 1909; Kultascheff, 1903.)

**CALCIUM SUCCINATE**  $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2$ .**CALCIUM (Iso) SUCCINATE**  $\text{CaCH}_2\text{CHC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ .

## SOLUBILITY OF EACH IN WATER.

(Miczynski, 1886.)

Calcium Succinate.				Calcium Iso Succinate.			
t°.	Gms. $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{Ca}(\text{C}_2\text{H}_3\text{O}_2)_2$ per 100 Gms. $\text{H}_2\text{O}$ .
0	1.127	50	1.029	0	0.522	50	0.440
10	1.220	60	0.894	10	0.524	60	0.396
20	1.276	70	0.770	20	0.517	70	0.342
40	1.177	80	0.657	40	0.475	80	0.279

100 cc.  $\text{H}_2\text{O}$  dissolve 1.424 gms.  $\text{CaC}_4\text{H}_4\text{O}_4 \cdot \text{H}_2\text{O}$  at 18° and 1.436 gms. at 25°

(Partheil and Hübner, 1903.)

100 gms.  $\text{H}_2\text{O}$  dissolve 1.28 gms.  $\text{CaC}_4\text{H}_4\text{O}_4$  at 15° and 0.66 gms. at 100°.

(Tarugi and Checchi, 1901.)

Results for calcium succinate in water, varying considerably from the above and indicating an increase of solubility with temperature, are given by Cantoni and Dintalevi (1905) but the terms used for expressing the results are not stated.

100 cc. 95% alcohol dissolve 0.00136 gm.  $\text{CaC}_4\text{H}_4\text{O}_4 \cdot \text{H}_2\text{O}$  at 18° and 0.00136 gm. at 25°.

(Partheil and Hübner, 1903.)



# CALCIUM SULFATE

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## CALCIUM SULFATE $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ .

### SOLUBILITY IN WATER.

(Hulett and Allen, 1902; for references to other determinations see Hulett and Allen, also Euler, 29 For data by the electrolytic conductivity method, see Holleman, Kohlrausch and Rose, 1893, 1908.)

t°.	Gms. $\text{CaSO}_4$ per 100 cc. Solution.	Millimols per Liter.	Density of Solutions.	t°.	Gms. $\text{CaSO}_4$ per 100 cc. Solution.	Millimols per Liter.	Density of Solutions.
0	0.1759	12.926	1.00197	40	0.2097	15.413	0.99439
10	0.1928	14.177	1.00173	55	0.2009	14.765	0.98796
18	0.2016	14.817	1.00059	65.3	0.1932	14.200	0.98256
25	0.2080	15.235	0.99911	75	0.1847	13.575	0.9777
30	0.2090	15.361	0.99789	100	0.1619	11.900	...
35	0.2096	15.405	0.99612	107	...	11.390	...

### SOLUBILITY OF CALCIUM SULFATE ANHYDRITE AND OF SOLUBLE ANHYDRITE IN WATER. (Melcher, 1910.)

t°.	Millimols per Liter.	Gms. $\text{CaSO}_4$ per Liter.	Solid Phase.
100	11.65	1.586	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
100	11.4	1.552	Soluble anhydrite
100	4.6	0.626	Anhydrite
156	3.2	0.436	Soluble anhydrite
156	1.35	0.184	Anhydrite
218	0.35	0.048	"

Data for the solubility of calcium sulfate in sea water are given by Manuelli, 100

### SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF AMMONIUM ACETATE AT 25°. (Marden, 1916.)

Gms. $\text{CH}_3\text{COONH}_4$ per 100 Gms. Solution.	ds.	Gms. $\text{CaSO}_4$ per 100 Gms. Sat. Solution.
0	1	0.2085
2.13	1.005	0.454
5.34	1.012	0.752
10.68	1.024	1.146
21.37	1.045	1.755

### SOLUBILITY OF CALCIUM SULPHATE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC, NITRIC, CHLOR ACETIC, AND FORMIC ACIDS.

(Banthisch — J. pr. Chem. 29, 52, '84; Lunge — J. Soc. Chem. Ind. 4, 32, '85.)

In Hydrochloric. In Nitric. In Chlor Acetic. In Formic

Grams Acid per 100 cc. Solution.	Grams $\text{CaSO}_4$ per 100 cc. Sol. at 25°.	Grams $\text{CaSO}_4$ per 100 cc. Solution at 25°.	Grams. $\text{CaSO}_4$ per 100 cc. Sol. at 25°.	Grams. $\text{CaSO}_4$ per 100 cc. Sol. at 25°.
0	0.208	0.160	0.208	0.208
1	0.72	1.38	0.56	...
2	1.02	2.38	0.82	...
3	1.25	3.20	1.02	...
4	1.42	3.64	1.20	0.22
6	1.65	4.65	1.48	...
8	1.74	...	1.70	...
10	...	...	1.84	0.25
12	...	...	1.98	...

Data for the solubility of mixtures of  $\text{CaSO}_4(\text{NH}_4)_2$ ,  $\text{SO}_4 \cdot \text{H}_2\text{O} + (\text{NH}_4)_2\text{SO}_4$  and  $\text{CaSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 4\text{H}_2\text{O} + \text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  at various temperatures between 3° and 10 are given by Barre, 1909 and 1911. Additional data for this system, including results for the pentacalcium salt,  $(\text{NH}_4)_5\text{Ca}_5(\text{SO}_4)_6 \cdot \text{H}_2\text{O}$ , are given by D'Ans, 1901



**SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF AMMONIUM SALTS.**

(In  $\text{NH}_4\text{Cl}$  and  $\text{NH}_4\text{NO}_3$ , Cameron and Brown — J. Physic. Chem. 9, 210, '05; In  $(\text{NH}_4)_2\text{SO}_4$  at 25°, Seidell — J. Am. Chem. Soc. 27, 529, '05; In  $(\text{NH}_4)_2\text{SO}_4$  at 50°, Bell and Tabor — J. Physic. Chem. 10, 119, '06.)

	In $\text{NH}_4\text{Cl}$ at 25°.		In $\text{NH}_4\text{NO}_3$ at 25°.		In $\text{NH}_4\text{Cl}$ at 25°.		In $\text{NH}_4\text{NO}_3$ at 25°.	
Gms. Ammonium Salt per Liter.	G. $\text{CaSO}_4$ Dissolved per Liter.	G. $\text{CaSO}_4$ Dissolved per Liter.	Gms. Ammonium Salt per Liter.	G. $\text{CaSO}_4$ Dissolved per Liter.	Gms. Ammonium Salt per Liter.	G. $\text{CaSO}_4$ Dissolved per Liter.	Gms. Ammonium Salt per Liter.	G. $\text{CaSO}_4$ Dissolved per Liter.
0	2.08	2.08	300	10.10	10.10	10.80		
20	5.00	3.70	375	7.40	...	...		
40	7.00	5.10	400	...	...	11.40		
60	8.00	6.05	600	...	...	12.15		
80	8.50	7.00	800	...	...	12.10		
100	9.10	7.65	1000	...	...	11.81		
150	10.30	8.88	1400	...	...	10.02		
200	10.85	9.85	sat.	...	...	7.55		

**In  $(\text{NH}_4)_2\text{SO}_4$  at 25°.**

Grams per Liter Sol.	Wt. of 100 cc.
$(\text{NH}_4)_2\text{SO}_4$ $\text{CaSO}_4$	Sat. Sol.
0	2.08
0.129	2.04
0.258	1.99
0.821	1.81
1.643	1.66
3.287	1.54
6.575	1.44
13.15	1.46
26.30	1.62
84.9	2.33
169.8	3.33
339.6	4.50

**In  $(\text{NH}_4)_2\text{SO}_4$  at 50°.**

Grams per Liter Sol.	Sp. Gr. of Solutions.
$(\text{NH}_4)_2\text{SO}_4$ $\text{CaSO}_4$	
0	2.168
15.65	1.609
30.67	1.750
91.6	2.542
160.4	3.402
221.6	4.068
340.6	5.084
416.5	5.354
428.4	4.632
530.8	2.152
566	1.08
566.7	0

**SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF CALCIUM SALTS AT 25°**

(Cameron and Seidell — J. Physic. Chem. 5, 643, '01; Seidell and Smith — *Ibid.* 8, 493, '04; Cameron and Bell — J. Am. Chem. Soc. 28, 1220, '06.)

In Calcium Chloride.		In Calcium Nitrate.		In Calcium Hydroxide and <i>vice versa.</i>	
Gms. per Liter Sol.		Gms. per Liter Sol.	Wt. of 1 cc. Sol.	Gms. per Liter Sol.	Solid Phase.
$\text{CaCl}_2$ $\text{CaSO}_4$		$\text{Ca}(\text{NO}_3)_2$ $\text{CaSO}_4$		$\text{CaO}$ $\text{CaSO}_4$	
0.00	2.06	0.0	2.08	0.0	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
7.49	1.24	25	1.24	0.062	"
11.96	1.18	50	1.20	0.176	"
25.77	1.10	100	1.13	0.349	"
32.05	1.08	200	0.93	0.61	"
51.53	1.02	300	0.76	0.939	"
97.02	0.84	400	0.57	1.222	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O} + \text{Ca}(\text{OH})_2$
192.71	0.47	500	0.40	1.242	$\text{Ca}(\text{OH})_2$
260.30	0.20	544	0.35	1.150	"
367.85	0.03	...	...	1.166	0.00



# CALCIUM SULFATE

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## SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF COPPER SULFATE AT 25°.

(Bell and Taber, 1907.)

Gms. per Liter Sat. Sol.		d <sub>m</sub> Sat. Sol.	Gms. per Liter Sat. Sol.		d <sub>m</sub> Sat. Sol.
CuSO <sub>4</sub> .	CaSO <sub>4</sub> .		CuSO <sub>4</sub> .	CaSO <sub>4</sub> .	
1.144	2.068	1.002	39.407	1.718	1.04
3.564	1.986	1.005	49.382	1.744	1.05
6.048	1.944	1.007	58.880	1.782	1.06
7.279	1.858	1.009	97.950	1.931	1.09
14.814	1.760	1.016	146.725	2.048	1.14
19.729	1.736	1.021	196.021	2.076	1.19
29.543	1.688	1.030	224.916	2.088	1.21

## SOLUBILITY OF MIXTURES OF CALCIUM SULFATE AND CALSIUM SULFATE WATER.

(D'Ans, 1908.)

t°.	Mols. CaSO <sub>4</sub> .CaSO <sub>4</sub> per 1000 Gms. Sat. Sol.	Gms. CaSO <sub>4</sub> .CaSO <sub>4</sub> per 1000 Gms. Sat. Sol.	Solid Phase.
25	0.667	352	Dicalcium Sulfate + Gypse
60	0.607	320	" "

## SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF MAGNESIUM CHLORIDE AND OF MAGNESIUM NITRATE AT 25°.

(Cameron, Seidell, and Smith.)

In Magnesium Chloride.			In Magnesium Nitrate.		Wt. of 1 cc Solution.
Grams per Liter of Sat. Solution.			Grams per Liter Solution.		
MgCl <sub>2</sub> .	CaSO <sub>4</sub> .	H <sub>2</sub> O.	Mg(NO <sub>3</sub> ) <sub>2</sub> .	CaSO <sub>4</sub> .	
0	2.08	997.9	0	2.08	0.998
8.50	4.26	996.5	25	5.77	1.020
19.18	5.69	994.5	50	7.88	1.035
46.64	7.59	989.1	100	9.92	1.071
121.38	8.62	972.2	200	13.34	1.14
206.98	6.57	949.9	300	14	1.21
337	2.77	908.7	400	14.68	1.21
441.1	1.39	878.6	514	15.04	1.3

## SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF MAGNESIUM SULFATE AT 25°.

(Cameron and Bell, 1906a.)

Grams per Liter Solution.		Sp. Gr. of Solutions at 25°.	Grams per Liter Solution.		S Sol
MgSO <sub>4</sub> .	CaSO <sub>4</sub> .		MgSO <sub>4</sub> .	CaSO <sub>4</sub> .	
0	2.046	1.0032	149.67	1.597	
3.20	1.620	1.0055	165.7	1.549	
6.39	1.507	1.0090	171.2	1.474	
10.64	1.471	1.0118	198.8	1.422	
21.36	1.478	1.0226	232.1	1.254	
42.68	1.558	1.0419	265.6	1.070	
64.14	1.608	1.0626	298	0.860	
85.67	1.617	1.0833	330.6	0.647	
128.28	1.627	1.1190	355	0.501	



TABLE OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF PHOSPHORIC  
ACID AT 25°.  
(Taber, 1906.)

	Gms. per Liter.	Sp. Gr. of Solutions at 25°.	Gms. per Liter.		Sp. Gr. of Solutions at 25°.
	CaSO <sub>4</sub>		P <sub>2</sub> O <sub>5</sub>	CaSO <sub>4</sub>	
	2.126	0.9991	145.1	7.920	1.106
	3.143	1.002	205	8.383	1.145
5	3.734	1.007	311.5	7.965	1.221
4	4.456	1.016	395.8	6.848	1.280
3	5.760	1.035	494.6	5.572	1.344
3	7.318	1.075			

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID.  
(Cameron and Breasale, 1903.)

Gms. H <sub>2</sub> SO <sub>4</sub> per Liter of Solution.	Results at 25°.		Results at 35°. Gms. CaSO <sub>4</sub> per Liter.	Results at 45°. Gms. CaSO <sub>4</sub> per Liter.
	Gms. CaSO <sub>4</sub> per Liter.	Wt. of 1 cc. Sol.		
0.00	2.126	0.9991 grams	...	2.145
0.48	2.128	1.0025 "	2.209	2.236
4.87	2.144	1.0026 "	2.451	2.456
8.11	2.203	1.0051 "	...	2.760
16.22	2.382	1.0098 "	...	3.116
48.67	2.727	1.0302 "	3.397	3.843
75.00	2.841	1.0435 "	...	4.146
97.35	2.779	1.0756 "	3.606	...
146.01	2.571	...	3.150	4.139
194.70	2.313	1.1134 "	...	3.551
243.35	1.901	1.1418 "	...	2.959
292.02	1.541	1.1681 "	...	2.481

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF POTASSIUM  
CHLORIDE, BROMIDE, AND IODIDE AT 21°.  
(Ditte, 1898.)

In KCl Solutions. In KBr Solutions. In KI Solutions.

Gms. of the Potassium Salt per Liter.	Gms. CaSO <sub>4</sub> per Liter.	Gms. CaSO <sub>4</sub> per Liter.	Gms. CaSO <sub>4</sub> per Liter.
0	2.05	2.05	2.05
10	3.6	3.1	2.8
20	4.5	3.6	3.2
40	5.8	4.5	3.9
60	6.6	5.2	4.5
80	7.2	5.9	4.85
100	7.5	6.3	5.1
125	double salt	6.7	5.45
150	...	7.0	5.8
200	...	7.3	5.95
250	...	double salt	6.00
300	...	...	double salt



SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF POTASSIUM NITRATE AND OF POTASSIUM SULFATE AT 25°.  
(Seidell and Smith, 1904; Cameron and Breazeale, 1904.)

In Potassium Nitrate.			In Potassium Sulfate.		
Gms. per Liter Solution.		Wt. of 1 cc. Solution.	Gms. per Liter Solution.		Wt. of 1 cc. Solution.
KNO <sub>3</sub> .	CaSO <sub>4</sub> .		K <sub>2</sub> SO <sub>4</sub> .	CaSO <sub>4</sub> .	
0.0	2.08	0.9981	0.0	2.08	0.9981
12.5	3.28	1.0081	4.88	1.60	1.0081
25.0	4.08	1.0154	5.09	1.56	1.0154
50.0	5.26	1.0321	9.85	1.45	1.0321
100.0	6.86	1.0625	19.57	1.49	1.0625
150	7.91	1.0924	28.35	1.55	1.0924
200	8.69	1.1224	30.66	1.57	1.1224
260	syngenite	1.1539	32.47	1.58*	1.1539

\* Solid phase syngenite. Results for the solubility of syngenite in solutions of potassium sulfate also given in the original paper.

Data for the solubility of syngenite,  $K_2Ca(SO_4)_2 \cdot H_2O$ , and of potassium sulfate,  $K_2Ca_2(SO_4)_6 \cdot H_2O$ , in water at various temperatures, are given by D'Ans (1909). This author also gives results for the effect of the following salts upon the concentration of the boundary solution for gypsum-potassium sulfate syngenite at 25°: KCl, KBr, KI, KClO<sub>3</sub>, KClO<sub>4</sub>, KNO<sub>3</sub>, CH<sub>3</sub>COOK, KOH, K<sub>4</sub>Fe(CN)<sub>6</sub>, NaCl, NaI, NaNO<sub>3</sub>, CH<sub>3</sub>COONa, HCl, HNO<sub>3</sub>, H<sub>3</sub>PO<sub>4</sub>, H<sub>2</sub>SO<sub>4</sub>, Ag<sub>2</sub>SO<sub>4</sub> and cane sugar.

Data for the solubility of mixtures of  $CaSO_4 \cdot K_2SO_4 \cdot H_2O + CaSO_4$  in water at temperatures between 0° and 40° are given by Barre (1909, 1911).

Data for mixtures of gypsum-rubidium syngenite and of dicalcium sulfate, at temperatures between 0° and 40°, are given by D'Ans (1909).

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE AT 26°.

(Cameron, 1901; also Orloff, 1902; Cloez, 1903; d'Anselme, 1903.)

Grams per 100 cc. Solution.		Wt. of 1 cc. Solution.	Grams per 100 cc. Solution.	
NaCl.	CaSO <sub>4</sub> .		NaCl.	CaSO <sub>4</sub> .
0	0.2121	0.9998	17.650	0.712
9.115	0.666	1.0644	22.876	0.679
14.399	0.718	1.0981	26.417	0.650
14.834	0.716	1.1012	32.049	0.572

SOLUBILITY OF MIXTURES OF CALCIUM SULFATE AND CALCIUM CARBONATE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE AT 23°.

(Cameron and Seidell, 1901a.)

Grams per Liter Solution.			Grams per Liter Solution.		
NaCl.	Ca(HCO <sub>3</sub> ) <sub>2</sub> .	CaSO <sub>4</sub> .	NaCl.	Ca(HCO <sub>3</sub> ) <sub>2</sub> .	CaSO <sub>4</sub> .
0	0.060	1.930	79.52	0.060	1.930
3.63	0.072	2.720	121.90	0.056	2.720
11.49	0.089	3.446	193.80	0.048	3.446
39.62	0.101	5.156	267.60	0.040	5.156

Data for the solubility of mixtures of calcium sulfate and sodium carbonate are given by Arth and Cretien (1906).

Data for the equilibrium  $CaSO_4 + Na_2CO_3 \rightleftharpoons CaCO_3 + Na_2SO_4$  are given by Herz (1911a).



SOLUBILITY OF MIXTURES OF CALCIUM SULFATE AND SILVER SULFATE IN WATER.

(Euler, 1904.)

t°.		Per Liter of Solution. Gms. Salt.	Gms. Equiv. Salt.	Total Salt per 100 Gms. Solution	Sp. Gr. of Solutions.
17°	CaSO <sub>4</sub>	2.31	0.034	0.9473	1.0083
	Ag <sub>2</sub> SO <sub>4</sub>	7.235	0.0464		
25°	CaSO <sub>4</sub>	2.61	0.0383	1.062	1.010
	Ag <sub>2</sub> SO <sub>4</sub>	8.11	0.0520		

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SOLUTIONS OF SODIUM NITRATE AND OF SODIUM SULFATE AT 25°.

(Seidell, Smith, Cameron, Breazeale.)

In Sodium Nitrate.			In Sodium Sulfate.		
Gms. per Liter Solution.		Wt. of 1 cc. Solution.	Gms. per Liter Solution.		Wt. of 1 cc. Solution.
NaNO <sub>3</sub>	CaSO <sub>4</sub>		Na <sub>2</sub> SO <sub>4</sub>	CaSO <sub>4</sub>	
0	2.08	0.9981	2.39	1.65	1.0013
25	4.25	1.0163	9.54	1.45	1.0076
50	5.50	1.0340	14.13	1.39	1.0115
100	7.10	1.0684	24.37	1.47	1.0205
200	8.79	1.1336	46.15	1.65	1.0391
300	9.28	1.1916	115.08	2.10	1.0965
600	7.89	1.3639	146.61	2.23	1.1427
655	7.24	1.3904	257.10	2.65	1.2120

Data for the solubility of calcium sulfate, sodium sulfate glauberite, sodium sulfate syngenite, separately and mixed, in water at various temperatures, are given by D'Ans (1909) and Barre (1911).

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS AND ALCOHOLIC MONO-POTASSIUM TARTRATE SOLUTIONS AT 20°.

(Magnanini, 1901.)

Solvent.	Gms. CaSO <sub>4</sub> per 100 Gms. Solution.	Solvent.	Gms. CaSO <sub>4</sub> per 100 Gms. Solution.
Water	0.2238	10% alcoholic N/200 KHC <sub>2</sub> H <sub>4</sub> O <sub>6</sub>	0.0866
Aq. N/200 KHC <sub>2</sub> H <sub>4</sub> O <sub>6</sub>	0.2323	Aq. N/200 KHC <sub>2</sub> H <sub>4</sub> O <sub>6</sub> +5% tar-	
10% alcohol	0.0970	tartic acid	0.2566
		10% alc. N/400 KHC <sub>2</sub> H <sub>4</sub> O <sub>6</sub> +5% tartaric acid	0.1086

SOLUBILITY OF CALCIUM SULFATE IN AQUEOUS SUGAR SOLUTIONS.

(Stolle, 1900.)

Per cent Concentration of Sugar Solutions.	Gms. CaSO <sub>4</sub> Dissolved by 1000 Gms. of the Sugar Solutions at:					
	30°.	40°.	50°.	60°.	70°.	80°.
0	...	2.157	1.730	1.730	1.652	1.710
10	2.041	1.730	1.730	1.574	1.574	1.613
20	1.808	1.652	1.419	1.380	1.419	1.263
27	1.550	1.438	1.361	1.283	1.283	0.972
35	1.263	1.050	1.088	1.108	0.914	...
42	1.030	...	0.777	0.816	0.855	0.729
49	...	0.564	0.739	0.564	0.603	0.486
55	...	0.486	0.505	0.486	0.369	0.330

100 gms. glycerol of  $d_{15}$  1.256 dissolve 5.17 gms. CaSO<sub>4</sub> at 15°-16°. (Ossendowski, 1907.)  
100 gms. glycerol of  $d$  1.114 dissolve 0.95 gm. CaSO<sub>4</sub> at ord. temp. (Asselin, 1873.)



## CALCIUM SULFATE

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FREEZING-POINT DATA (Solubilities, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES OF CALCIUM SULFATE AND OTHER SALTS:

Calcium Sulfate + Lithium Sulfate	(Müller, 1910.)
" " + Potassium Sulfate	(Müller, 1910; Grahmann, 1913.)
" " + Rubidium Sulfate	(Müller, 1910.)
" " + Sodium Sulfate	(Müller, 1910; Calcagni and Mancini, 1910.)

## CALCIUM SULPHIDE CaS.

SOLUBILITY IN AQUEOUS SUGAR SOLUTIONS.  
(Stolle.)

Per cent Concentration of Sugar Solutions.	Grams CaS Dissolved per Liter of the Sugar Solutions at:						
	30°.	40°.	50°.	60°.	70°.	80°.	90°.
0	1.982	2.123	1.235	1.390	1.606	2.032	2.496
10	1.866	1.316	1.441	1.673	1.560	1.634	1.544
20	2.187	1.696	1.802	1.905	1.879	1.892	1.930
27	2.522	2.097	2.059	2.226	2.342	2.304	2.357
35	2.689	2.265	2.304	2.406	2.342	2.857	2.947
42	2.342	2.136	2.226	2.522	2.574	2.509	2.689
49	2.445	2.290	2.458	2.638	2.728	2.818	3.063
55	2.509	2.226	2.340	2.882	2.766	2.972	3.616

## CALCIUM SULFITE $\text{CaSO}_3 \cdot 2\text{H}_2\text{O}$ .

SOLUBILITY IN WATER AND IN AQUEOUS SUGAR SOLUTIONS AT 18°.  
(Weisberg, 1896.)

Solvent.	Grams $\text{CaSO}_3$ per 100 cc. Solution.	
	At 18°.	After Boiling Solution 2 Hours.
Water	0.0043	....
10 Per cent Sugar	0.0083	0.0066
30 Per cent Sugar	0.0080	0.0069

RESULTS AT HIGHER TEMPERATURES.  
(Van der Linden, 1916.)

Solvent.	Gms. $\text{CaSO}_3 \cdot 2\text{H}_2\text{O}$ per 1000 gms. Sat. Solution at.							
	30°.	40°.	50°.	60°.	70°.	80°.	90°.	b. pt.
Water	0.064	0.063	0.057	0.061	0.045	0.031	0.027	0.011
Aq. Sucrose of 15 gms. per 100 cc.	0.103	0.083	0.073	0.080	0.059	0.041	0.036	0.041
Aq. Sucrose, 15 gms. + 1.5 gms. Glucose per 100 cc.	0.104	0.081	0.085	0.071	0.060	0.047	0.040	0.029
Water + Excess $\text{CaSO}_4$	0.031	0.029	0.025	0.019	0.012	0.009	0.008	0.006
Aq. Sucrose, 15 gms. per 100 cc. + Excess $\text{CaSO}_4$	0.035	0.032	0.022	0.019	0.021	0.017	0.020	0.021
Aq. Sucrose, 15 gms. + 1.5 gms. Glucose per 100 cc. + Excess $\text{CaSO}_4$	0.032	0.027	0.022	0.020	0.019	0.019	0.019	0.022

## CALCIUM Phenanthrene SULFONATES.

SOLUBILITY IN WATER.  
(Sandquist, 1912.)

Compound.	Gms. Anhydrous <del>Sulfonate</del> per 100 Gms. <del>H<sub>2</sub>O</del>
Calcium- 2-Phenanthrene Monosulfonate	0.024
" - 3- " " .2H <sub>2</sub> O	0.083
" -10- " " .2H <sub>2</sub> O	0.30



**CALCIUM TARTRATE**  $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Cantoni and Zachoder, 1905.)

t°.	Gms. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ per 100 cc. Sol.	t°.	Gms. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ per 100 cc. Sol.	t°.	Gms. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ per 100 cc. Sol.
0	0.0365	30	0.0631	70	0.1430
10	0.0401	40	0.0875	80	0.1798
20	0.0475	50	0.1100	85	0.2190
25	0.0525	60	0.1262		

100 gms. aq. Ca. tartrate solution contain 0.0185 gm.  $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$  at 18°, and 0.029489 gm. at 25°.

100 gms. 95% alcohol solution contain 0.0187 gm.  $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$  at 18°, and 0.02352 gm. at 25°.

(Partheil and Hübner, 1903.)

100 gms. aq. Ca. tartrate solution contain 0.0364 gm.  $\text{CaC}_4\text{H}_4\text{O}_6$  at 20°.

100 gms. 10% alcohol solution contain 0.0160 gm.  $\text{CaC}_4\text{H}_4\text{O}_6$  at 20°.

100 gms. aqueous 5% tartaric acid solution contain 0.1632 gm.  $\text{CaC}_4\text{H}_4\text{O}_6$  at 20°.

(Magnanini, 1901.)

SOLUBILITY OF CALCIUM TARTRATE,  $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ , IN AQUEOUS ACETIC ACID SOLUTIONS AT 26°-27°.

(Herz and Muhs, 1903; see also Enell, 1899.)

Normality of Acetic Acid.	Gms. $\text{CH}_3\text{COOH}$ per 100 cc. Sol.	Residue from 50.052 cc. Sol.	Normality of Acetic Acid.	Gms. $\text{CH}_3\text{COOH}$ per 100 cc. Sol.	Residue from 50.052 cc. Sol.
0	0	0.0217	3.80	22.80	0.2042
0.57	3.42	0.1082	5.70	34.20	0.1844
1.425	8.55	0.1635	10.09	60.54	0.1160
2.85	17.10	0.1970	16.505	93.03	0.0337

The residue was dried at 70° C.

## SOLUBILITY OF CALCIUM TARTRATE IN AQUEOUS SOLUTIONS OF CALCIUM CHLORIDE, TARTARIC ACID, ETC., AT 18°.

(Paul, 1915.)

(The determinations were made by weighing the tartrate remaining undissolved and calculating the amount dissolved by difference. It was found that even a small amount of  $\text{CO}_2$  in the water had a distinct influence on the solubility. One liter of pure  $\text{CO}_2$  free water was found to dissolve 0.380 gm.  $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$  at 18° and one liter of ordinary distilled water, 0.410 gm. at the same temperature.)

Results for Aqueous Calcium Chloride Solution.		Results for Aqueous Dipotassium Tartrate Sols.		Results for Aqueous Tartaric Acid Sols.		Results for Alcoholic Tartaric Acid Sols.		
Gms. per Liter.		Gms. per Liter.		Gms. per Liter.		Gms. per Liter.		
$\text{CaCl}_2$	$\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	$\text{K}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	$\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	$\text{C}_4\text{H}_6\text{O}_6$	$\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	$\text{C}_4\text{H}_6\text{OH}$	$\text{C}_4\text{H}_6\text{O}_6$	$\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$
0.503	0.202	0.392	0.166	1	0.910	50	0	0.263
1.005	0.179	2.139	0.160	2	1.162	"	4	1.107
3.518	0.166	2.352	0.157	4	1.511	"	16	1.85
4.523	0.154	2.614	0.150	6	1.776	80	0	0.205
5.025	0.154	4.705	0.223	8	1.972	"	4	0.867
7.538	0.171	23.524	0.263	10	2.205	"	16	1.506
10.05	0.177	47.048	0.305	12	2.380	100	0	0.190
25.125	0.182			14	2.514	"	4	0.766
50.25	0.224			16	2.643	"	16	1.297

Data for the effect of potassium chloride and of potassium acetate upon the solubility of calcium tartrate in aqueous 0.5 normal acetic acid solutions at 25°, and also for the effect of potassium monochloracetate upon the solubility of the salt in 0.5 normal chloracetic acid solutions at 25°, are given by Henderson and Taylor (1916).



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(Cantoni and Jolkowsky, 1907.)

er	Gms. Ca Tartrate Dissolved at 16° per Liter of Aq.:			°.	Gms. Ca Tartrate per Liter of 7% Aqueous:		
	NH <sub>4</sub> Cl.	KCl.	NaCl		NH <sub>4</sub> Cl.	KCl.	NaCl.
0.701	0.643	0.680	16	1.676	1.504	1.631	
0.861	0.822	0.840	30	2.417	2.031	2.275	
1.281	1.180	1.305	55	3.712	2.154	3.579	
1.897	1.753	1.860	70	5.080	2.546	4.148	
2.305	2.110	2.163	85	6.609	4.264	6.305	

(Warington — J. Chem. Soc. 28, 946, '75.)

Gms. $\text{CaH}_2(\text{C}_2\text{H}_3\text{O}_2)_2$ per 100 Gms. Solvent.		Acid or Salt.	Gms. Acid or Salt per 100 cc. Sol.	Gms. $\text{CaH}_2(\text{C}_2\text{H}_3\text{O}_2)_2$ per 100 cc. Sol.
At 22°.	At 80°.			
0.600	4.027	Acetic Acid	0.81	0.422
3.01	5.35	Tartaric Acid	1.03	0.322
5.88	11.35	Citric Acid	0.84	0.546
1.19	20.23	Sulphuric Acid	0.685	1.701
2.75	40.93	Hydrochloric Acid	0.504	1.947
3.31	80.12	Nitric Acid	0.845	1.069
		Potassium Acetate	1.387	0.744
		Potassium Citrate	1.397	0.843

1) dissolve 0.422 gms. at 14°

(Kremann and Rodemund, 1914.)

ms.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
		$\text{Na}_2\text{S}_2\text{O}_3$ .	$\text{CaSO}_3$ .	
9.4	$\text{CaS}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$	0	34.7	$\text{CaS}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$
2.64	"	9.24	29.69	"
5.84	" + $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$	15.67	21.41	"
7.70	$\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$	18.34	25.18	"
		28.24	21.14	"
		30.19	20.33	" + $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$
		31.24	18.43	$\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$
		35.04	11.61	"

Also given for the quaternary systems,  $\text{CaS}_2\text{O}_3 + \text{Na}_2\text{S}_2\text{O}_3 + \text{NaNO}_3$ ,  $\text{Na}_2\text{S}_2\text{O}_3 + \text{Ca}(\text{NO}_3)_2 + \text{NaNO}_3 + \text{H}_2\text{O}$  at 9° and 25°. A triple salt of the  $\text{CaNa}_3(\text{S}_2\text{O}_3)_2\text{NO}_3 \cdot 11\text{H}_2\text{O}$  was obtained.



**CALCIUM VALERATE**  $\text{Ca}[\text{CH}_2(\text{CH}_2)_3\text{COO}]_2 \cdot \text{H}_2\text{O}$ .

**CALCIUM (Iso) VALERATE**  $\text{Ca}[(\text{CH}_3)_2\text{CH} \cdot \text{CH}_2\text{COO}]_2 \cdot 3\text{H}_2\text{O}$ .

SOLUBILITY OF EACH IN WATER.

(Anala — J. Chem. Soc. 81, 355, '03; see also Furth — Monatsh. Chem. 9, 313, '88; Sedlitzky — *Ibid.*, 8, 566, '87.)

Calcium Valerate.			Calcium Iso Valerate.			
t°.	Gms. $\text{Ca}(\text{C}_4\text{H}_9\text{O}_2)_2$ per 100 Gms.		t°.	Gms. $\text{Ca}(\text{C}_4\text{H}_9\text{O}_2)_2$ per 100 Gms.		Solid Phase.
	Water.	Solution.		Water.	Solution.	
0	9.82	8.94	0	26.05	20.66	$\text{Ca}(\text{C}_4\text{H}_9\text{O}_2)_2 \cdot 3\text{H}_2\text{O}$
10	9.25	8.47	10	22.70	18.50	"
20	8.80	8.09	20	21.80	17.90	"
30	8.40	7.75	30	21.68	17.82	"
40	8.05	7.45	40	22.00	18.18	"
50	7.85	7.28	45.5	22.35	18.42	"
57	7.75	7.19	50	19.95	16.63	$\text{Ca}(\text{C}_4\text{H}_9\text{O}_2)_2 \cdot \text{H}_2\text{O}$
60	7.78	7.22	60	18.38	15.52	"
70	7.80	7.24	70	17.40	14.82	"
80	7.95	7.36	80	16.88	14.44	"
90	8.20	7.58	90	16.65	14.28	"
100	8.78	8.07	100	16.55	14.20	"

**CAMPHENE**  $\text{C}_{10}\text{H}_{18}$ .

Freezing-point data (solubility, see footnote, p. 1) are given by Kurnakov and Zinov (1912) for mixtures of camphene + methylmustard oil, camphene + naphthalene and camphene + phenanthrene.

**CAMPHOR**  $\text{C}_{15}\text{H}_{10}\text{O}$  *d* and *l*.

APPROXIMATE SOLUBILITY OF *d* CAMPHOR IN SEVERAL SOLVENTS AT ORDINARY TEMPERATURE. (U. S. P., Squires; Greenish and Smith, 1903.)

Solvent.	Parts Camphor per 100 Parts Solvent.	Solvent.	Parts Camphor per 100 Parts Solvent.
Water	0.08–0.14	Chloroform	300–400
% Alcohol	100	Olive Oil	25–33
% Alcohol	125	Turpentine	66
Water	173	Glacial Acetic Acid	200
Carbon Disulfide	Readily Soluble	Lanolin	12.5 (Klose, 1907).

Saturated solutions of *d* camphor and of *l* camphor in turpentine of  $\alpha_D = 4.38$  in a 10 cm. tube at 18° were found to have  $d_{18} = 0.9028$  and  $0.9030$  respectively;  $\alpha_D$  in a 10 cm. tube were +23.07 and –16.52 respectively. (Jones, 1907–08.)

SOLUBILITY OF CAMPHOR IN CONCENTRATED AQUEOUS HYDROCHLORIC ACID. (Zaharia, 1899.)

The dissolved camphor could not be determined by evaporating and weighing the residue on account of volatility; polarimetric methods could not be used on account of the interference of the HCl. The author, therefore, determined the densities (at 4° in each case) of the pure solvent and saturated solution in each case, assuming that the difference represented the weight of camphor dissolved. Saturated solutions were prepared by stirring the several mixtures with a glass stirring rod, at intervals, during 6 hours.)

Solvent.	Densities at 0°.		Densities at 10°.		Densities at 20°.		Densities at 40°.	
	Solvent.	Sat. Sol.	Solvent.	Sat. Sol.	Solvent.	Sat. Sol.	Solvent.	Sat. Sol.
% HCl	1.145	1.143	1.140	1.138	1.135	1.133	1.125	1.123
"	1.164	1.159	1.158	1.153	1.153	1.148	1.142	1.138
"	1.181	1.167	1.175	1.163	1.169	1.159	1.157	1.149
8 "	1.187	1.158	1.181	1.160	1.175	1.158	1.163	1.153
6 "	1.191	1.140	1.185	1.148	1.179	1.153	1.167	1.153
5 "	1.195	1.126	1.189	1.134	1.182	1.140	1.170	1.153
5 "	1.197	1.116	1.190	1.124	1.184	1.134	...	...



RECIPROCAL SOLUBILITY OF CAMPHOR AND PHENOL, DETERMINED BY THE  
FREEZING-POINT METHOD.

(Wood and Scott, 1910.)

(The freezing-point was determined in most cases by measuring the rate of cooling of the mixtures and ascertaining the point at which the rate changed. The experiments were made with very great care.)

t° of Freezing.	Gms. Camphor per 100 Gms. Mixture.	Solid Phase.	t° of Freezing.	Gms. Camphor per 100 Gms. Mixture.	Solid Phase.	t° of Freezing.	Gms. Camphor per 100 Gms. Mixture.	Solid Phase.
174.5	100.0	C <sub>10</sub> H <sub>16</sub> O	-13.8	71.48	C <sub>10</sub> H <sub>16</sub> O	-22.6	52.52	1:1
158	95.98	"	-26.4, -32	70.12	" + 1:1	-23.6	44.90	"
140	92.55	"	-15.9	69.32	1:1	-28-30.5	40.35	" + C <sub>6</sub> H <sub>5</sub> OH
112	88.86	"	-20.1	67.76	"	-15.7	38.57	C <sub>6</sub> H <sub>5</sub> OH
80	82.88	"	-19.3	66.64	"	-3	34.50	"
50.7	79.73	"	-18.7	62.21	"	+5	30.31	"
29.5	76.58	"	-18.6 m. pt.	...	"	16.1	25.40	"
-0.1	73.37	"	-20.1	61.51	"	25	20.31	"
-13.5	72.24	"	-20	55.80	"	36.1	6.87	"

1:1 = C<sub>10</sub>H<sub>16</sub>O.C<sub>6</sub>H<sub>5</sub>OH.

Data for the above system obtained by the method of determination of the temperature of disappearance of the last crystal, are given by Kremann, Wischo and Paul (1915). The results are not in good agreement with the above. These authors also give similar determinations for the systems camphor + resorcinol and camphor +  $\beta$  naphthol.

Data for the systems camphor + phenol + water, camphor + *n* butyric acid + water, camphor + succinic acid nitrile + water and camphor + triethylamine + water are given by Timmermans, 1907.

Freezing-point data (solubilities, see footnote, p. 1) are given for the following mixtures of camphor and other compounds.

Camphor + Borneol	(Vanstone, 1909.)
" + Hydroquinone	(Efremov, 1912, 1913.)
" + Menthol	(Pawlewski, 1913.)
" + $\alpha$ Naphthol	(Caille, 1909.)
" + $\beta$ Naphthol	(Caille, 1909.)
" + $\alpha$ Mononitronaphthalene	(Journiaux, 1912.)
" + Naphthalene	" "
" + $\beta$ Naphthylamine	" "
" + Nitric Acid	(Zukow and Kasatkin, 1909.)
" + Phosphoric Acid	" "
" + Pyrocatechol	(Efremov, 1912, 1913.)
" + Pyrogallol	(Journiaux, 1912.)
" + Resorcinol	(Caille, 1909; Efremov, 1912, 1913.)
" + Salol	(Caille, 1909.)
" + Sulfur Dioxide	(Bellucci and Grassi, 1913, 1914.)
" + $\alpha$ Trinitrotoluene	(Giua, 1916.)
" + <i>p</i> Toluidine	(Efremov, 1915, 1916.)
" + 17 other compounds	" "

**BenzolCAMPHOR** Enol and keto forms.

Solubility data have been used by Dimroth and Mason (1913) for determining the transition of the tautomeric forms into each other. Results are given for the solubility of each form in ether, acetone, ethylacetate, ethyl alcohol and methyl alcohol.

One liter benzene dissolves 256 gms. *enol* benzoylcamphor at 5°, by freezing-point method.

(Sidgwick, 1915.)



**BromoCAMPHOR**  $\alpha$   $C_{15}H_{11}OBr$ :

**APPROXIMATE SOLUBILITY IN SEVERAL ORGANIC SOLVENTS AT ORDINARY TEMP.**  
(U. S. P.; Squires; Beilstein; results in alcohol by Müller, 1892.)

Solvent.	Parts Bromo Camphor per 100 Parts Solvent.	Solvent.	Parts Bromo Camphor per 100 Parts Solvent.
Alcohol	12.1 at 15°	Ether	50
"	19.7 " 25°	Chloroform	143
"	130.0 " 50°	Olive Oil	12.5
"	705.0 " 61°	95% Formic Acid	13.6 (Aschan, 1913.)

Freezing-point data (solubility, see footnote, p. 1) are given for mixtures of *l*-bromocamphor + *d*-chlorocamphor by Padoa (1904); for mixtures of *d*-bromocamphor + *l*-bromocamphor by Padoa and Rotondi (1912); for mixtures of bromocamphor + stearine by Batelli and Martinetti (1885);  $\beta$ -bromocamphor + salol by Caille, 1909.

**CAMPHOROXIME**  $C_{15}H_{11}NOH$  *d* and *l*.

100 gms. turpentine dissolve 8.68 gms. *d* oxime at 18°,  $d_{15} = 0.8784$ ,  $\alpha_D = 2.30$  in 10 cm. tube.

100 gms. turpentine dissolve 8.69 gms. *l* oxime at 18°,  $d_{15} = 0.8782$ ,  $\alpha_D = 18.24$  in 10 cm. tube.

$\alpha_D$  of the turpentine = 4.38 in a 10 cm. tube at 18°.

In the case of results in *l*-amyl bromide the  $d_{15} = 1.199$  in both cases and the  $\alpha_D$  was -3.55 (10 cm. tube) for the *d* oxime and +11.48 for the *l* oxime. The  $\alpha_D$  of the *l*-amyl bromide was +4.6 in 10 cm. tube at 18°. The results show that the solubility and rotatory power of the *d* and *l* isomerides are identical in an optically active as well as in an inactive solvent.

Freezing-point data are given for mixtures of *d* and *l* camphoroxime by Beck (1904) and Adriani (1900).

**CAMPHORIC ACID**  $C_{15}H_{11}(COOH)_2$ .

100 gms. of water dissolve 0.8 gm.  $C_{15}H_{11}(COOH)_2$  at 25°, and 10 gms. at the b. pt. (U.S.P.)

**SOLUBILITY OF CAMPHORIC ACID IN AQUEOUS SOLUTIONS OF ALCOHOL AT 25°.**  
(Seidell, 1908, 1910.)

Wt. % $C_2H_5OH$ in Solvent.	$d_m$ of Sat. Sol.	Gms. $C_{15}H_{11}(COOH)_2$ per 100 Gms. Sat. Sol.	Wt. % $C_2H_5OH$ in Solvent.	$d_m$ of Sat. Sol.	Gms. $C_{15}H_{11}(COOH)_2$ per 100 Gms. Sat. Sol.
0	1	0.754	60	1	45
10	1	1.50	70	1	49
20	1	6.30	80	0.995	51.20
30	1	14	90	0.980	51.40
40	1	26	96.3	0.970	50.37
50	1	31	100	0.960	50.10

**SOLUBILITY OF CAMPHORIC ACID IN SEVERAL SOLVENTS.**

Solvent.	t°.	$d_m$ of Sat. Sol.	Gms. $C_{15}H_{11}(COOH)_2$ per 100 Gms. Solvent.	Solvent.	t°.	$d_m$ of Sat. Sol.	Gms. $C_{15}H_{11}(COOH)_2$ per 100 Gms. Solvent.
Amyl Alcohol(iso)	25	0.907	50(3)	Carbon Disulfide	25	1.258	0.020(3)
Butyl Alcohol(iso)	22.5	...	54.1(1)	Chloroform	25	...	0.153(3)
Ethyl Alcohol	0	...	84.7(1)	Cumene	25	0.890	0.197(3)
"	15.1	...	112(2)	Ether (abs.)	25	0.922	91.40(3)
"	62.5	...	147(2)	95% Formic Acid	18.5	...	8.68(4)
Methyl Alcohol	0	...	116.3(1)	Ligroin	25	0.714	0.007(3)
"	22.5	...	131.1(1)	Nitrobenzene	25	1.2	0.5(3)
Propyl Alcohol	0	...	42.2(1)	Spts. Turpentine	25	0.852	1.74(3)
"	22.5	...	61 (1)	Toluene	25	0.862	0.15(3)
Benzene	25	0.873	0.008(3)	Xylene	25	0.859	0.23(3)

(1) Timofiew (1914); (2) Beilstein; (3) Seidell (1910); (4) Aschan, (1913).

Data for the distribution of camphoric acid between water and ether at 25° are given by Chandler (1908). Data for the freezing points of mixtures of *d* and *l* camphoric acid and *d* and *l* isocamphoric acid are given by Centnerszwer (1899).

**CAMPHORIC ANHYDRIDE**  $C_{15}H_{11}O_2$  *d* and *l*.

One liter of benzene dissolves 37.5 gms. *d* camphoric anhydride at 5°, determined by depression of the freezing-point. (Sidgwick, 1915.)



## SOLUBILITY OF CARBON DIOXIDE IN WATER AT HIGH PRESSURES. (Sander, 1911-12.)

NOTE. — The pressures varied from 25 to 170 kilograms per square centimeter. The results are expressed in terms of the volume of  $\text{CO}_2$ , reduced to 1 kg. per sq. centimeter, dissolved by unit volume of liquid at the temperature and pressure of the experiment. A Caillet apparatus, provided with the well-known Caillet tube, was used. The experiments were made with very great care. In general, the procedure consisted in compressing  $\text{CO}_2$  above mercury in the closed millimeter graduated end of the Caillet tube and taking many readings on the scale at various pressures and temperatures. The volumes thus found were compared with similar readings made after a known amount of solvent had been introduced above the layer of mercury, by means of a graduated pipet with turned-up end. The differences show the volume of  $\text{CO}_2$  dissolved at given temperatures and pressures.

Two series of determinations were made. In the case of the results marked (a) the used volume of water was 0.210 cc. and for those marked (b) the volume was 0.102 cc. The volumes of  $\text{CO}_2$  used, varied from 60 to 76 cc.

t°.	Pressure in Kg. per Sq. Cm.	cc. of $\text{CO}_2$ (Reduced to 1 Kg. per Sq. Cm.) Dis- solved by 1 cc. $\text{H}_2\text{O}$ .		t°.	Pressure in Kg. per Sq. Cm.	cc. $\text{CO}_2$ (Reduced to 1 Kg. per Sq. Cm.) Dissolved by 1 cc. $\text{H}_2\text{O}$ .	
		(a)	(b)			(a)	(b)
20	25	...	17.77	60	90	22.74	21.16
"	30	...	19.77	"	100	26.22	27.85
"	40	...	21.52	"	110	28.92	28.79
"	50	...	28.09	"	120	30.20	33.90
"	55	...	29.75	100	60	8.97	...
35	30	11.77	13.57	"	70	10.11	6.40
"	40	14.82	20	"	80	11.05	9.59
"	50	18.96	24.64	"	90	12.62	10.85
"	60	22.90	22.50	"	100	13.63	12.40
"	70	27.18	27.62	"	110	14.88	16.31
"	80	...	32.85	"	120	16.40	15.78
60	40	10.88	9.80	"	130	17.93	16.89
"	50	12.24	13.72	"	140	19.56	17.71
"	60	14.46	15.28	"	150	20.58	17.49
"	70	16.80	17.46	"	160	22.07	...
"	80	19.74	22.67	"	170	22.78	...

SOLUBILITY OF CARBON DIOXIDE IN WATER EXPRESSED IN TERMS OF THE FAHR-  
ENHEIT SCALE OF TEMPERATURE AND POUNDS PER SQUARE INCH PRESSURE.

(Heath, 1915; Anthony, 1916, see also Riley, 1911.)

(The existing data were calculated to this form, particularly for use in the bottling industry.)

Pounds per Sq. Inch Pressure	Volumes of CO <sub>2</sub> Gas Dissolved by One Volume of Water at:													
	32°.	36°.	40°.	44°.	48°.	55°.	60°.	65°.	70°.	75°.	80°.	85°.	90°.	
15	3.46	3.19	2.93	2.70	2.50	2.20	2.02	1.86	1.71	1.58	1.84	4.35	1.27	
20	4.04	3.73	3.42	3.15	2.92	2.57	2.36	2.17	2	1.84	1.69	1.58	1.48	
25	4.58	4.27	3.92	3.61	3.35	2.94	2.69	2.48	2.29	2.10	1.93	1.80	1.70	
30	5.21	4.81	4.41	4.06	3.77	3.31	3.03	2.80	2.58	2.37	2.18	2.03	1.91	
35	5.80	5.35	4.91	4.52	4.19	3.69	3.37	3.11	2.86	2.63	2.42	2.26	2.13	
40	6.37	5.89	5.39	4.97	4.61	4.05	3.71	3.42	3.15	2.89	2.67	2.49	2.34	
45	6.95	6.43	5.88	5.43	5.03	4.43	4.06	3.74	3.44	3.16	2.91	2.72	2.56	
50	7.53	6.95	6.36	5.89	5.45	4.80	4.40	4.05	3.73	3.42	3.16	2.94	2.77	
55	8.11	7.48	6.86	6.34	5.87	5.17	4.74	4.37	4.02	3.69	3.40	3.17	2.99	
60	8.71	8.02	7.35	6.79	6.29	5.53	5.08	4.68	4.31	3.95	3.64	3.39	3.20	
70	9.86	9.09	8.33	7.70	7.13	6.27	5.76	5.30	4.89	4.49	4.14	3.86	3.63	
80	11.02	10.17	9.31	8.61	7.98	7	6.43	5.92	5.46	5.02	4.62	4.31	4.06	
90	12.18	11.25	10.30	9.52	8.82	7.74	7.11	6.54	6.04	5.55	5.12	4.77	4.49	
100	13.34	12.33	11.29	10.43	9.66	8.4	7.79	7.18	6.62	6.08	5.60	5.22	4.91	



**SOLUBILITY OF CO<sub>2</sub> IN AQUEOUS SOLUTIONS OF ACIDS AND SALTS.**  
(Geffcken.)

Aq. Solvent.	Gms. Acid per Liter.	CO <sub>2</sub> Dissolved, l at:		Aq. Solvent	Gms. Salt per Liter.	CO <sub>2</sub> Dissolved, l at:	
		15°.	25°.			15°.	25°.
HCl	18.23	1.043	0.806	CsCl	84.17	1.006	0.781
"	36.46	1.028	0.799	KCl	37.30	0.976	0.759
"	72.92	1.000	0.795	KCl	74.60	0.897	0.700
HNO <sub>3</sub>	31.52	1.078	0.840	KI	83.06	0.992	0.775
"	63.05	1.086	0.853	KI	166.12	0.923	0.727
"	126.10	1.100	0.877	KBr	59.55	0.986	0.768
H <sub>2</sub> SO <sub>4</sub>	24.52	1.018	0.794	KBr	119.11	0.914	0.713
"	49.04	0.978	0.770	KNO <sub>3</sub>	50.59	1.005	0.784
"	98.08	0.917	0.730	KNO <sub>3</sub>	101.19	0.946	0.749
"	147.11	0.870	0.698	RbCl	60.47	0.989	0.769
"	196.15	0.828	0.667	RbCl	120.95	0.921	0.788

**SOLUBILITY IN AQUEOUS SOLUTIONS OF SALTS.** (Mackenzie, 1877.)

Salt in Solution.	Gms. Salt per 100 Gms. Solution.	Density of Solution 15°.	Absorption Coefficient $\alpha$ at:			
			8°.	15°.	22°.	
KCl	6.05	1.021	0.988	0.777	0.670	
"	8.646	1.053	0.918	0.777	0.649	
"	11.974	1.080	0.864	0.720	0.597	
"	22.506	1.549	0.688	0.571	0.480	
NaCl	7.062	1.038	0.899 (6.4°)	0.735	...	
"	12.995	1.080	0.633 (6.4°)	0.557	0.482	
"	17.42	1.123	0.518 (6.4°)	0.431	0.389	
"	26.00	1.195	0.347 (6.4°)	0.297	0.263	
NH <sub>4</sub> Cl	6.465	1.021	1.023	0.825	0.718	
"	8.723	1.047	1.000	0.791	0.702	
"	12.727	1.053	0.922	0.798	0.684	
"	24.233	1.072	0.813 (10°)	0.738	0.600	
			8°.	16.5°.	22°.	30°.
BaCl <sub>2</sub>	7.316	1.068	0.969	0.744	0.680	0.566
"	9.753	1.092	1.021	0.645	0.607	0.543
"	14.030	1.137	...	0.618	0.524	0.467
"	25.215	1.273	0.495	0.618	0.383	0.315
SrCl <sub>2</sub>	9.511	1.087	0.779	0.663	0.581	0.508
"	12.325	1.1159	0.737	0.586	0.507	0.539
"	17.713	1.173	0.606	0.473	0.444	0.367
"	31.194	1.343	0.285	0.245	0.247	0.223
CaCl <sub>2</sub>	4.365	1.036	0.942	0.759	0.673	0.596
"	5.739	1.049	0.855	0.726	0.616	0.527
"	8.045	1.068	0.838	0.674	0.581	0.500
"	15.793	1.139	0.632	0.520	0.471	0.400

Data for the solubility of CO<sub>2</sub> in sea water are given by Hamberg (1885).

According to Fox (1909a), analyses of sea water all show an excess of base over acid, that is, when CO<sub>2</sub> is left out of account. This CO<sub>2</sub> (about 50 cc. per liter) is, of course, in equilibrium with the excess of base, which is actually equal to about 40 mgs. OH per liter. The partial pressure of CO<sub>2</sub> very seldom, if ever, exceeds 6 in 10,000. For the determination of the absorption coefficient of CO<sub>2</sub> there are, consequently, four independent variables to be considered; influence of alkalinity, a chemical influence in addition to the purely physical influences of temperature, pressure and salinity. For convenience, the dissolved CO<sub>2</sub> may be considered as made up of two parts, about 1% dependent upon physical influences alone and a far larger part dependent upon the alkalinity, pressure and temperature, but independent of salinity. Extensive experimental determinations are described.

A critical review of the literature on the solubility of carbon dioxide in water and in sea water is given by Coste (1917).



SOLUBILITY OF CARBON DIOXIDE IN AQUEOUS SOLUTIONS OF SALTS A  
(Setchenow, 1892.)(Results expressed in terms of cc. CO<sub>2</sub> (at 0° and 760 mm.) dissolved in sat. solution.)

Salt.	Gms. Salt per Liter.	Dis-solved CO <sub>2</sub> .	Salt.	Gms. Salt per Liter.	Dis-solved CO <sub>2</sub> .	Salt.	Gms. Salt per Liter.
NH <sub>4</sub> Cl	1	1.005	LiCl	16.72	1.035	NaCl	12.9
"	10	0.985	"	50.15	0.808	"	64
"	51.6	0.941	"	125.4	0.596	"	128
"	172	0.819	"	250.8	0.497	"	192
"	258	0.770	"	501.5	0.120	NaBr	115.1
NH <sub>4</sub> NO <sub>3</sub>	2.8	1.013	MgSO <sub>4</sub>	26.5	0.901	"	460.3
"	11.2	1.002	"	79.5	0.669	"	690.4
"	55	0.989	"	159	0.441	NaNO <sub>3</sub>	89.3
"	101	0.962	"	318	0.188	"	125
"	202.1	0.911	KBr	83.9	0.908	"	208.4
"	404.3	0.807	"	167.7	0.819	"	416.8
"	810.4	0.612	"	251.5	0.748	"	625.2
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	72.2	0.712	"	503.1	0.579	NaClO <sub>3</sub>	233.3
"	144.4	0.575	KI	319.1	0.777	"	349.9
Ba(NO <sub>3</sub> ) <sub>2</sub>	62.7	0.922	"	478.6	0.688	"	699.8
Ca(NO <sub>3</sub> ) <sub>2</sub>	41	0.923	"	957.3	0.506	Na <sub>2</sub> SO <sub>4</sub>	14.2
Citric Acid	12	1.007	KSCN	326	0.691	"	94.8
"	49	0.975	"	489	0.590	"	284.4
"	99	0.950	"	978	0.387	ZnSO <sub>4</sub>	38.3
"	198	0.893	KNO <sub>3</sub>	58.8	0.959	"	76.7
"	298	0.841	"	117.5	0.890	"	230
"	595	0.719	"	235.1	0.781	"	460

Several determinations at other temperatures are also given.

SOLUBILITY OF CARBON DIOXIDE IN AQUEOUS SALT SOLUTIONS AT :  
(Findlay and Shen, 1912.)

Salt.	Gms. Salt per 100 cc. Solution.	d of Sat. Sol.	Solubility of CO <sub>2</sub> , Ostwald Ex-pression l <sub>m</sub> .	Salt.	Gms. Salt per 100 cc. Solution.	d of Sat. Sol.
Water alone	...	...	0.825	Fe(SO <sub>4</sub> )(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> ·6H <sub>2</sub> O	9.51	1.052
NH <sub>4</sub> Cl	2.35	1.005	0.791	"	10.26	1.057
"	5.05	1.013	0.754	"	22.47	1.124
"	10.02	1.022	0.732	KCl	1.84	1.008
"	17.09	1.045	0.665	"	3.05	1.017
BaCl <sub>2</sub>	2.80	1.018	0.789	"	4.58	1.026
"	5.81	1.040	0.741	"	7.46	1.044
"	8.15	1.054	0.710	Sucrose	2.63	1.009
"	9.97	1.070	0.676	"	5.16	1.018
Chloral Hy- drate	5.08	1.019	0.815	"	9.68	1.038
"	10.12	1.041	0.795	"	12.33	1.051

Data for KCl solutions at higher pressures are given by Findlay and Creighton, 1910.

Data for the influence of colloids and fine suspensions upon the solubility of carbon dioxide in water at 25° and at various pressures are given by Findlay and Creighton, 1910, 1911; Findlay and Shen, 1911, 1912; Findlay and Williams, 1913; Findlay and Howell, 1915.

The solubility of CO<sub>2</sub> increases slightly with increasing concentration of Fe(OH)<sub>3</sub>, gelatine, silicic acid, aniline (chem. combination occurs), methyl blood, serum, peptone, protopeptone, and commercial hemoglobin. The solubility diminishes slightly with increasing concentrations of arsenious dextrine, soluble starch, glycogen (?), egg albumen and serum albumen. An appreciable effect is produced by suspensions of charcoal or silica.

When the solubility is increased by a given substance, the solubility curve rises with increase of pressure; when it is lessened, the curve rises with increase of pressure. In the case of starch and other neutral colloids, the solubility passes through a minimum with increase of pressure.

Data for the influence of colloids and suspensions on the evolution of CO<sub>2</sub> from supersaturated solutions, are given by Findlay and King, 1913-14.



ABILITY OF CARBON DIOXIDE IN AQUEOUS SALT SOLUTIONS AT 15.5° AND 760 MM. PRESSURE.  
(Christoff, 1905.)

gravimetric method was used. A stream of CO<sub>2</sub> was passed through the salt solution and, after saturation, the solution again weighed and the difference taken to represent absorbed CO<sub>2</sub>. The loss of water from the solution prevented by first passing the CO<sub>2</sub> through a series of U-tubes containing some same solution. Constant temp. was not employed, but corrections of the were made for the slight variations in temp. which occurred. Absorption of special shape, graduated to hold 75 cc., were used.

in Aq. Solution.	Conc. of Aq. Sol.	Gms. CO <sub>2</sub> Absorbed per 75 cc. Solvent.	Salt in Aq. Solution.	Conc. of Aq. Sol.	Gms. CO <sub>2</sub> Absorbed per 75 cc. Solvent.
Alone	...	0.1382	K <sub>4</sub> P <sub>4</sub> O <sub>13</sub>	1 normal	0.1237
SO <sub>4</sub>	1 normal	0.1093	KHSO <sub>4</sub>	0.66 "	0.1020
Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·24H <sub>2</sub> O	1 "	0.0991	"	2. "	0.1000
SO <sub>4</sub> ·24H <sub>2</sub> O	1 "	0.1054	K <sub>2</sub> SO <sub>4</sub>	0.66 "	0.1140
B <sub>2</sub> O <sub>3</sub>	0.25 "	0.7672	"	1 "	0.1002
	2 "	0.0751	Na <sub>4</sub> B <sub>4</sub> O <sub>7</sub>	0.025 "	0.2205
	1 "	0.1087	"	0.125 "	0.5317
	0.5 "	0.1209	"	0.25 "	0.8511
	1 "	0.1020	"	sat. sol.	1.8285
	2 "	0.0662	"	" +crysts.	3.2240
	4 "	0.0527	NaBO <sub>2</sub>	0.25 normal	0.8122
	1 "	0.1280	NaCl	1 "	0.1050
	1 "	0.1213	Na <sub>3</sub> PO <sub>4</sub> ·12H <sub>2</sub> O	1 "	0.5828
	1 "	0.1204	Na <sub>4</sub> P <sub>2</sub> O <sub>7</sub> ·10H <sub>2</sub> O	1 "	0.8463
	1 "	0.1231	Na <sub>4</sub> P <sub>4</sub> O <sub>13</sub>	1 "	0.0700
SO <sub>4</sub>	0.5 "	0.1110	ZnSO <sub>4</sub>	2 "	0.0720
NaO <sub>4</sub>	1 "	0.0812	Sugar	0.1 "	0.1225
O <sub>4</sub>	1 "	0.0860	"	0.5 "	0.1089
O <sub>4</sub>	0.5 "	0.4900(?)	"	1 "	0.0931

ABILITY OF CARBON DIOXIDE IN AQUEOUS SOLUTIONS OF SULFURIC ACID.

Results at 15.5°. (Christoff, 1905.)

Results at 20°. (Christoff, 1906.)

wt. %	Gms. CO <sub>2</sub> Absorbed per 75 cc. Solvent.	Per cent H <sub>2</sub> SO <sub>4</sub> in Solvent.	Gms. CO <sub>2</sub> Absorbed per 75 cc. Solvent.	Per cent H <sub>2</sub> SO <sub>4</sub> in Solvent.	Solubility of CO <sub>2</sub> , Ostwald Expression $\beta$ .
5	0.1282	40	0.0713	0	0.9674
	0.1079	45	0.0725	35.82	0.6521
	0.0833	70	0.0918	61.62	0.7191
	0.0755	90	0.1433	95.6	0.9924
	0.0751			96	$\beta = 0.926$ (Bohr, 1910.)

ABILITY OF CARBON DIOXIDE IN AQUEOUS SOLUTIONS OF CHLORAL HYDRATE AND OF GLYCEROL AT 15°.

Results in terms of the Bunsen absorption coefficient  $\beta$ , and also the Ostwald solubility expression  $l$  (see p. 227). (von Hammel, 1915.)

In Aq. Chloral Hydrate.			In Aq. Glycerol.		
Gms. CH <sub>2</sub> (OH) per 100 Gms. Aq. Sol.	Abs. Coef., $\beta_{15}$ .	Solubility, $l_{15}$ .	Gms. (CH <sub>2</sub> OH) <sub>2</sub> CHOH per 100 Gms. Aq. Sol.	Abs. Coef., $\beta_{15}$ .	Solubility, $l_{15}$ .
17.7	0.885	0.935	0	1.008	1.064
31.6	0.803	0.848	26.11	0.785	0.829
38.3	0.781	0.825	43.72	0.639	0.675
49.8	0.760	0.802	62.14	0.511	0.540
57.1	0.765	0.808	77.75	0.430	0.454
68.8	0.797	0.842	90.74	0.404	0.427
79.4	0.903	0.953	99.26	0.410	0.438



## SOLUBILITY OF CARBON DIOXIDE IN ALCOHOL.

(Bohr — Wied. Ann. Physik. [4] 1, 247, '00)

In 99 per cent Alcohol.

In 98.7 per cent Alcohol.

t°.	cc. CO <sub>2</sub> (at 0° and 760 mm.) per 1 cc.		cc. CO <sub>2</sub> (at 0° and 760 mm.) per 1 cc.	
	Alcohol.	Sat. Solution.	Alcohol.	Sat. Solution.
-65	38.41	35.93	39.89	37.22
-20	7.51	7.41	7.25	7.16
-10	5.75	5.69	5.43	5.38
0	4.44	4.40	4.35	4.31
+10	3.57	3.55	...	...
20	2.98	2.96	...	...
25	2.76	2.74	...	...
30	2.57	2.56	...	...
40	2.20	2.19	...	...
45	2.01	2.00	...	...

## SOLUBILITY IN AQUEOUS ALCOHOL AT 20°.

(Müller, 1889; Lubarsch, 1889.)

Density of Alcohol.	Per cent Alcohol by Wt.	Abs. Coef. of CO <sub>2</sub> , α.	Density of Alcohol.	Per cent Alcohol by Wt.	Abs. Coef. of CO <sub>2</sub> , α.
0.998	1.07	0.861	0.922	49.0	0.982
0.969	22.76	0.841	0.870 (18.8°)	71.1	1.293
0.960 (22.4°)	28.46	0.792	0.835 (16°)	85.3	1.974
0.956	31.17	0.801	0.795 (19°)	99.7	2.719
0.935 (17°)	42.15	0.877			

## SOLUBILITY IN AQUEOUS ALCOHOL AT 25°.

(Findlay and Shen, 1911.)

Results for alcohol, of $d_{44}^2 = 0.9931$ (2.95 gms. per 100 cc.).		Results for alcohol, of $d_{44}^2 = 0.9929$ (3.01 gms. per 100 cc.).		Results for alcohol, of $d_{44}^2 = 0.9834$ (8.83 gms. per 100 cc.).	
Pressure m.m. Hg.	Solubility of CO <sub>2</sub> , Ostwald Expression $\frac{1}{m}$ .	Pressure m.m. Hg.	Solubility of CO <sub>2</sub> , Ostwald Expression $\frac{1}{m}$ .	Pressure m.m. Hg.	Solubility of CO <sub>2</sub> , Ostwald Expression $\frac{1}{m}$ .
737	0.812	745	0.814	747	0.786
836	0.813	937	0.815	942	0.784
1073	0.811	1083	0.813	1090	0.785
1338	0.811	1357	0.812	1360	0.788

These authors also showed that the solubility of CO<sub>2</sub> in wort containing 13 gms. solids per 100 cc. is less than in water; also that the solubility of CO<sub>2</sub> in beer is less than in aqueous alcohol solutions of alcohol content equal to that of the beer.

## SOLUBILITY OF CARBON DIOXIDE IN AQUEOUS SOLUTIONS OF NON-ELECTROLYTES AT 20°.

Results in terms of the Bunsen Absorption Coefficient  $\beta$ , see p. 227. (Usher, 1910.)

Aqueous Solution of:	Gm. Mols. per Liter.	$d_{20}^4$ of Aq. Sol.	Absorption Coef. $\beta$ .	Aqueous Solution of:	Gm. Mols. per Liter.	$d_{20}^4$ of Aq. Sol.	Absorption Coef. $\beta$ .
Water Alone	...	...	0.877	Resorcinol	0.5	1.0096	0.901
Sucrose	0.125	1.0152	0.846	Catechol	0.5	1.0107	0.868
"	0.25	1.0313	0.815	Urethan	0.5	1.0037	0.869
"	0.50	1.0637	0.756	Carbamide	0.5	1.0072	0.864
"	1	1.1281	0.649	Thiocarbamide	0.5	1.0092	0.859
Dextrose	0.5	1.0328	0.792	Antipyrine	0.5	1.0134	0.859
Mannitol	0.5	1.0303	0.782	Acetamide	0.5	1.0005	0.879
Glycine	0.5	1.0141	0.843	Acetic Acid	0.5	1.0026	0.868
Pyrogallol	0.5	1.0172	0.853	n Propyl Alcohol	0.5	0.9939	0.869
Quinol	0.5	1.0095	0.887				



**SOLUBILITY OF CARBON DIOXIDE IN ORGANIC SOLVENTS AT LOW TEMPERATURES AND PRESSURES.** (Stern, 1912-13.)

Very accurate determinations with an elaborate apparatus. The results are expressed in terms of  $K'$  = the number of cc. of  $\text{CO}_2$ , reduced to  $0^\circ$ , absorbed at the indicated pressure by 1 gram of liquid. This number differs from the Bunsen absorption coefficient only by a constant factor which is the density  $d$  of the liquid. Therefore Bunsen coef.  $\beta = K'd$ . The results are also expressed in terms of the Ostwald solubility expression  $l$  (see p. 227).

°.	Pressure in m.m. Hg.	Solvent, $\text{C}_2\text{H}_5\text{OH}$ .		Solvent, $\text{CH}_3\text{OH}$ .		Solvent, $(\text{CH}_3)_2\text{CO}$ .		Solvent, $\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$ .		Solvent, $\text{CH}_3\text{CO}_2\text{CH}_3$ .	
		$d_{-25} = 0.872$ .	$d_{-25} = 0.856$ .	$d_{-25} = 0.884$ .	$d_{-25} = 0.866$ .	$d_{-25} = 0.900$ .	$d_{-25} = 0.879$ .	$d_{-25} = 1.017$ .	$d_{-25} = 0.994$ .	$d_{-25} = 1.056$ .	$d_{-25} = 1.032$ .
		$K'$ .	$l$ .	$K'$ .	$l$ .	$K'$ .	$l$ .	$K'$ .	$l$ .	$K'$ .	$l$ .
-78	50	107	...	194	120.5	311	196.6	250.2	177.5	304.9	224.1
"	100	111.8	68.4	195	119.6	322	198.1	255.6	177.1	315	224.3
"	200	115.7	69.5	202.9	120.1	344.5	201.5	271.8	179.2	337.4	223.1
"	400	123.8	71.4	221.5	122.2	400	208.8	310.9	183.2	389.3	225.6
"	700	138.6	74.7	260	126.8	545.5	...	...	...	...	...
-59	100	40.85	27.27	63	42.5	97.8	67.2	85.3	65.6	94.3	75.8
"	200	41	27.16	64.2	42.7	101.2	68	86.3	65.3	98.45	77.1
"	400	42.35	27.65	66.3	43.1	106.6	72.8	91.6	66.7	103.6	77.6
"	700	44.15	28.10	69	43.35	118.8	72.8	101.5	69.7	112.9	79

**SOLUBILITY OF CARBON DIOXIDE IN ORGANIC SOLVENTS AT HIGH PRESSURES.**  
(See Note, p. 228.) (Sander, 1911-12.)

Pressure in Kg. per Sq. Cm.	Cc. of $\text{CO}_2$ (Reduced to 1 Kg per Sq. Cm.) Dissolved at the Temp. and Pressure of Experiment by 1 cc. of Sat. Solution in:								
	$\text{C}_2\text{H}_5\text{OH}$ (0.093 cc.)	$\text{C}_2\text{H}_5\text{OH}$ (0.103 cc.)	$(\text{C}_2\text{H}_5)_2\text{O}$ (0.131 cc.)	$\text{CH}_3\text{COOC}_2\text{H}_5$ (0.155 cc.)	$\text{C}_6\text{H}_6$ (0.08 cc.)	$\text{C}_6\text{H}_5\text{Cl}$ (0.106 cc.)	$\text{C}_6\text{H}_5\text{Br}$ (0.113 cc.)	$\text{C}_6\text{H}_5\text{NO}_2$ (0.164 cc.)	$\text{C}_6\text{H}_5\text{CH}_3$ (0.114 cc.)
Results at $20^\circ$ .									
20	...	56.16	...	...	71.16	62.61	50.83	57.12	57.91
30	104.8	86.62	...	188.2	125.3	95.22	82.29	92.50	103.3
40	149.7	122.1	...	227.9	192.4	137.3	121.1	115.9	155.9
50	188.8	174.6	...	...	264.3	187.5	160	155.9	235.8
Results at $35^\circ$ .									
20	...	40	...	...	48.65	46.66	43.38	44.48	49.6
40	113.1	98.16	...	188.4	138.3	101.5	90.43	94.39	118.8
60	173	159.9	241.3	219.8	243.1	168.3	146	145.1	192.1
80	...	269.6	...	...	...	...	233.9	227	...
Results at $60^\circ$ .									
20	...	24.73	...	...	34.57	35.86	30.58	31.38	...
40	72.82	64.65	...	140.5	88.71	73.69	62.64	52.26	78.67
60	122.5	111.5	195.4	186.7	156.6	118.1	98.73	72.15	128.1
80	167.9	159.2	221.4	223.4	215	149.3	131.4	85.03	171.9
100	195.7	213.9	248.7	...	284.4	...	169.7	...	210
Results at $100^\circ$ .									
30	...	...	...	...	...	33.65	30.56	41.09	28.68
40	...	26.5	...	80.70	46.52	48.16	41.49	50.36	49.25
60	66.05	74.51	101	132	91.27	77.24	72.64	70.85	85.98
80	111.2	107.7	142.8	162.3	155.8	103	92.86	86.86	117.6
100	145.7	144.7	175.4	191.5	212.9	121.5	118	...	149
120	174.6	175.4	...	...	258.2	140.7	140.7	...	171.8
130	182.6	...	...	...	...	146.8	...	...	178.2

The figures in parentheses immediately below the formulas of the solvents in the above table, show the volumes of solvent used for the series of determinations in each case. The volumes of  $\text{CO}_2$  varied from about 55 to 77 cc. in the several cases. The increasing content of  $\text{CO}_2$  in the solvents at increasing pressures caused a considerable increase in volume of the solvent. This was determined and the proper calculation of the readings to the saturated solution were made. All necessary figures to show the extent of the applicability of Henry's Law in the present case, are given.



## SOLUBILITY OF CARBON DIOXIDE IN ORGANIC SOLVENTS.

(Just, 1901.)

The determinations are described in great detail. Results are given in terms of the Ostwald solubility expression  $l$  (see p. 227).

Solvent.	$l_m$	$l_n$	$l_s$	Solvent.	$l_m$	$l_n$	$l_s$
Water	0.8256	...	...	Benzene	2.425	2.540	2.710
Glycerol	0.0302	...	...	Amylbromide	2.455	2.638	2.803
Carbon Disulfide	0.8699	0.8888	0.9446	Nitrobenzene	2.456	2.655	2.845
Iodobenzene	1.301	1.371	1.440	Propyl Alcohol	2.498	...	...
Aniline	1.324	1.434	1.531	Carvol	2.498	2.690	2.914
<i>o</i> Toluidine	1.381	1.473	1.539	Ethyl Alcohol (97%)	2.706	2.923	3.130
"	1.436	1.581	1.730	Benzaldehyde	2.841	3.057	3.304
Eugenol	1.539	1.653	1.762	Amylchloride	2.910	3.127	3.363
Benzene Trichloride	1.643	...	...	Isobutylchloride	3.105	3.388	3.639
Cumol	1.782	1.879	1.978	Chloroform	3.430	3.681	3.936
Carven	1.802	1.921	2.030	Butyric Acid	3.478	3.767	4.064
Dichlorhydrine	1.810	1.917	2.034	Ethylene Chloride	3.525	3.795	4.061
Amyl Alcohol	1.831	1.941	2.058	Pyridine	3.656	3.862	4.091
Bromobenzene	1.842	1.964	2.092	Methyl Alcohol	3.837	4.205	4.606
Isobutyl Alcohol	1.849	1.964	2.088	Amylformate	4.026	4.329	4.646
Benzylchloride	1.938	2.072	2.180	Propionic Acid	4.078	4.407	4.787
Metoxylol	2.000	2.216	2.346	Amyl Acetate	4.119	4.411	4.890
Ethylenebromide	2.157	2.294	2.424	Acetic Acid (glacial)	4.679	5.129	5.614
Chlorobenzene	2.205	2.420	2.581	Isobutyl Acetate	4.691	4.968	...
Carbontetrachloride	2.204	2.502	2.603	Acetic Anhydride	5.206	5.720	6.218
Propylenebromide	2.301	2.453	2.586	Acetone	6.295	6.921	...
Toluene	2.305	2.426	2.557	Methyl Acetate	6.494	...	...

SOLUBILITY OF CARBON DIOXIDE IN ETHYL ETHER. RESULTS IN TERMS OF THE OSTWALD SOLUBILITY EXPRESSION  $l$ .

(Christoff, 1912.)

$$l_0 = 7.330.$$

$$l_{10} = 6.044.$$

$$l_{15} = 5.465.$$

Data for the solubility of carbon dioxide in mixtures of acetic acid and carbon tetrachloride and of ethylene chloride and carbon disulfide are given by Christoff, 1905.

Data for the adsorption of  $\text{CO}_2$  by *p* azoxyphenetol at temperatures below and above its melting point, show that no adsorption or solution occurs while the material is in the solid (unmelted) condition, but after the first melting, absorption takes place and as soon as the isotropic liquid phase is reached, a second very well-marked increase in absorption is observed. After this, expansion and decrease of solubility proceed regularly with rise of temp. (Homfray, 1900.)

The absorption coefficient  $\beta$  of  $\text{CO}_2$  in Russian petroleum was found by Gniewosz and Walfisz (1887) to be 1.17 at  $20^\circ$  and 1.31 at  $10^\circ$ .

Data for the absorption of  $\text{CO}_2$  by rubber and carbon are given by Reychler (1910).

Data for the absorption of  $\text{CO}_2$  by hemoglobin are given by Jolin (1889).

Data for the distribution of  $\text{CO}_2$  between air and  $\text{H}_2\text{O}$ , air and aq.  $\text{H}_2\text{SO}_4$  and air and toluene at various temperatures, are given by Hantzsch and Vagt (1901).

Data for the freezing-points of mixtures of  $\text{CO}_2$  and methyl-ether and for  $\text{CO}_2$  and methyl alcohol are given by Baume and Perrot (1911, 1914).



IN DISULFIDE CS<sub>2</sub>.

## SOLUBILITY IN WATER.

(Chance and Parmentier, 1885; Rex, 1906.)

t°.	Grams CS <sub>2</sub> per 100		t°.	Grams CS <sub>2</sub> per 100	
	cc. Solution.	Gms. H <sub>2</sub> O (Rex).		cc. Solution.	Gms. H <sub>2</sub> O (Rex).
0	0.204	0.258	30	0.155	0.195
5	0.199	...	35	0.137	...
10	0.194	0.239	40	0.111	...
15	0.187	...	45	0.070	...
20	0.179	0.217	49	0.014	...
25	0.169	...			

0 cc. H<sub>2</sub>O dissolve 0.174 cc. CS<sub>2</sub> at 22°; Vol. of solution = 100.208, Sp. Gr. =

81.

10 cc. CS<sub>2</sub> dissolve 0.961 cc. H<sub>2</sub>O at 22°; Vol. of solution = 100.961, Sp. Gr. =

3.

(Herz, 1898.)

## SOLUBILITY OF CARBON DISULFIDE IN:

1. Solutions of Ethyl Alcohol at 17°.

(Tuchschmidt and Follweis, 1871.)

Methyl Alcohol.

(Rothmund, 1898.)

Pt. per cent Alcohol.	cc. CS <sub>2</sub> per 100 cc. Solvent.	Wt. per cent Alcohol.	cc. CS <sub>2</sub> per 100 cc. Solvent.	t°.	Wt. per CS <sub>2</sub> in:	
					CH <sub>3</sub> OH Layer.	CS <sub>2</sub> Layer.
100	00	91.37	50	10	45.1	98.3
98.5	182	84.12	30	20	50.8	97.2
98.15	132	76.02	20	25	54.2	96.4
96.95	100	48.40	2	30	58.4	95.5
93.54	70	47.90	0	35	64	93.5
				40.5 (crit. temp.)	80.5	

## SOLUBILITY OF CARBON DISULFIDE IN ETHYL ALCOHOL. (Guthrie, 1884.)

Gms. CS<sub>2</sub> per 100  
Gms. CS<sub>2</sub> + C<sub>2</sub>H<sub>5</sub>OH.Appearance on Cooling in Ice and  
Salt Mixture.

94.94	Remains clear down to -18.4
89.54	Becomes turbid at -14.4
84.89	" " " -15.9
79.96	" " " -16.1
65.11	" " " -17.7
59.58	Remains clear down to -20
29.92	" " " " "

## CARBON MONOXIDE CO.

## SOLUBILITY IN WATER. (Winkler, 1901.)

p.	β, "Absorp. Coef."	β', "Solubility."	q.	t°.	β, "Absorp. Coef."	β', "Solubility."	q.
0	0.03537	0.03516	0.0044	40	0.01775	0.01647	0.0021
5	0.03149	0.03122	0.0039	50	0.01615	0.01420	0.0018
10	0.02816	0.02782	0.0035	60	0.01488	0.01197	0.0015
15	0.02543	0.02501	0.0031	70	0.01440	0.00998	0.0013
20	0.02319	0.02266	0.0028	80	0.01430	0.00762	0.0010
25	0.02142	0.02076	0.0026	90	0.01420	0.00438	0.0006
30	0.01998	0.01915	0.0024	100	0.01410	0.00000	0.0000

β = vol. of CO absorbed by 1 volume of the liquid at a partial pressure of 760

mm. See p. 227.

β' = vol. of CO (reduced to 0° and 760 mm.) absorbed by 1 volume of the liquid under a total pressure of 760 mm.

q = grams of CO dissolved by 100 grams H<sub>2</sub>O at a total pressure of 760 mm.



## SOLUBILITY OF CARBON MONOXIDE IN WATER AND AQUEOUS SOLUTIONS.

The solubility in water, in terms of the Ostwald solubility expression (see p. 227), was found by Findlay and Creighton (1911) to be  $l_{25} = 0.0154$ .

Data for the solubility of CO in water at high pressures are given by Cassuto, 1913.

Data for the solubility of CO in aq. NaOH solutions are given by Fonda, 1910.

Results for the solubility of CO in aq.  $H_2SO_4$  at  $20^\circ$  are given in terms of the Ostwald solubility expression  $l$  by Christoff (1906) as follows:

$l_{25}$  for  $H_2O = 0.02482$ ,  $l_{25}$  for 35.82%  $H_2SO_4 = 0.0114$ ,  $l_{25}$  for 61.62%  $H_2SO_4 = 0.00958$ ,  $l_{25}$  for 95.6%  $H_2SO_4 = 0.02327$  and 0.02164.

Data for the solubility of CO in ox blood and ox serum at  $25^\circ$  are given by Findlay and Creighton, 1910-11.

Data for the influence of time on the absorption of CO by blood are given by Grehaut (1894). The author passed air containing from one part CO per 1000 to one part CO per 60,000, through 100 cc. portions of blood and found that the maximum absorption, 18.3 cc. CO per 100 cc. of blood (for the 1 : 1000 mixture) occurred in three hours.

Data for the solubility of CO in aqueous hemoglobin solutions are given by Hufner (1895) and Hufner and Kulz (1895).

SOLUBILITY OF CARBON MONOXIDE IN AQUEOUS ALCOHOL SOLUTIONS  
AT  $20^\circ$  AND 760 MM. PRESSURE.

(Lubarsch, 1889.)

Wt. % Alcohol.	Vol. % Absorbed CO.	Wt. % Alcohol.	Vol. % Absorbed CO.
0	2.41	28.57	1.50
9.09	1.87	33.33	1.94
16.67	1.75	50	3.20
23.08	1.68		

## SOLUBILITY OF CARBON MONOXIDE IN ORGANIC SOLVENTS.

(Just, 1901.)

Results in terms of the Ostwald Solubility Expression, see p. 227.

Solvent.	$l_{25}$ .	$l_{10}$ .	Solvent.	$l_{25}$ .	$l_{10}$ .
Water	0.02404	0.02586	Toluene	0.1808	0.1742
Aniline	0.05358	0.05055	Ethyl Alcohol	0.1921	0.1901
Carbon Disulfide	0.08314	0.08112	Chloroform	0.1954	0.1897
Nitrobenzene	0.09366	0.09105	Methyl Alcohol	0.1955	0.1830
Benzene	0.1707	0.1645	Amyl Acetate	0.2140	0.2108
Acetic Acid	0.1714	0.1689	Acetone	0.2225	0.2128
Amyl Alcohol	0.1714	0.1706	Isobutyl Acetate	0.2365	0.2314
Xylene	0.1781	0.1744	Ethyl Acetate	0.2516	0.2419

100 volumes of petroleum absorb 12.3 vols. CO at  $20^\circ$ , and 13.4 vols. at  $10^\circ$ .  
(Guicewas and Walfisz, 1887.)

## SOLUBILITY OF CARBON MONOXIDE IN ETHYL ETHER.

(Christoff, 1912.)

Results in terms of the Ostwald solubility expression, see p. 227.

$$l_0 = 0.3618.$$

$$l_{10} = 0.3842.$$



**SOLUBILITY OF CARBON MONOXIDE IN MIXTURES OF ACETIC ACID AND  
OTHER SOLVENTS AT 25°.**

(Skirow, 1902.)

Results in terms of the Ostwald solubility expression, see p. 227.

Mixture of Acetic Ac. and:	Wt. % CH <sub>3</sub> COOH in Mixture.	CO. l <sub>h</sub> .	Mixture of Acetic Ac. and:	Wt. % CH <sub>3</sub> COOH in Mixture.	CO. l <sub>h</sub> .
Aniline	100	0.173	Chloroform	56.4	0.196
"	86.5	0.110	"	0	0.206
"	58.3	0.070	Nitrobenzene	78.4	0.156
"	17.8	0.058	"	49	0.130
"	0	0.053	"	0	0.093
Benzene	67.5	0.199	Toluene	74.7	0.191
"	33.5	0.198	"	56.9	0.195
"	19.2	0.190	"	20.5	0.190
"	0	0.174	"	0	0.182

**SOLUBILITY OF CARBON MONOXIDE IN MIXTURES OF ACETONE AND  
OTHER SOLVENTS AT 25°.**

(Skirow.)

Mixture of Acetone and:	% (CH <sub>3</sub> ) <sub>2</sub> CO in Mixture. By Wt.	CO. l <sub>h</sub> .	Mixture of Acetone and:	% (CH <sub>3</sub> ) <sub>2</sub> CO in Mixture. By Wt.	CO. l <sub>h</sub> .
Aniline	100	0.238	Chloroform	66.6	0.226
"	79.2	0.179	"	26.5	0.212
"	44.9	0.110	"	0	0.207
"	0	0.053	β Naphthol	86	0.190
Carbon Disulfide	82	0.236	"	73.1	0.169
"	50.5	0.227	Nitrobenzene	78.4	0.207
"	26	0.187	"	46.8	0.157
"	14.5	0.144	"	0	0.093
"	0	0.096	Phenanthrene	87.2	0.205
Naphthalene	86.7	0.199	"	75	0.183
"	72.6	0.187			

**SOLUBILITY OF CARBON MONOXIDE IN MIXTURES OF BENZENE AND  
OTHER SOLVENTS AT 25°.**

(Skirow, 1902.)

The solubility of the CO given in terms of the Ostwald expression, see p. 227.

Mixture of Benzene and:	% C <sub>6</sub> H <sub>6</sub> in Mixture. By Wt.	CO. l <sub>h</sub> .	Mixture of Benzene and:	% C <sub>6</sub> H <sub>6</sub> in Mixture. By Wt.	CO. l <sub>h</sub> .
Naphthalene	100	0.174	Aniline	87.3	0.156
"	88.5	0.164	"	71.7	0.131
"	66.2	0.141	"	42.6	0.095
Phenanthrene	89.5	0.144	"	21.2	0.068
"	72.6	0.127	"	0	0.053
β Naphthol	96.5	0.149	Nitrobenzene	71.8	0.152
"	87.9	0.139	"	45.1	0.127
α Naphthol	97.9	0.158	"	0	0.093
"	95.6	0.149	Ethyl Alcohol	47.7	0.181
			"	0	0.192



**SOLUBILITY OF CARBON MONOXIDE IN MIXTURES OF TOLUENE  
OTHER SOLVENTS AT 25°.**

(Skirrow, 1902.)

Mixture of Tol- uene and:	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> in Mixture.		CO. gms.	Mixture of Tol- uene and:	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> in M	
	Wt. %.	Mol. %.			Wt. %.	Mol. %.
Aniline	100	100	0.182	α Naphthol	95.5	97
"	93.4	93.5	0.169	"	91.2	94
"	80.1	80.3	0.148	Nitrobenzene	81.7	85
"	55.4	55.6	0.115	"	50.8	58
"	25.4	25.6	0.077	"	23.7	29
"	0	0	0.053	"	0	0
Naphthalene	92.9	94.8	0.169	Phenanthrene	94.4	97
"	84.9	88.7	0.161	"	88.8	93
"	77.3	82.5	0.153	"	78.4	87

**SOLUBILITY OF CARBON MONOXIDE IN MIXTURES OF ORGANIC SOLVENTS**  
(Skirrow.)

Mixture Composed of:	% of Latter in Mixture.	
	By Wt.	By Mol.
Chloroform and Methyl Alcohol	0.0	
"	13.0	
"	100	
Carbon Bisulphide and Ethyl Di Chloride		100
"		75
"		51
"		18.4
"		0.0
Methyl Alcohol and Glycerine	0.0	0.0
"	39.6	30.1
"	60.5	50.1
"	77.1	68.9
"	100.0	100.0

NOTE. — From the results shown in the preceding five t concluded that the solubility of carbon monoxide in various of organic solvents is, in general, an additive function.

**CARBON OXYSULFIDE COS.**

**SOLUBILITY OF CARBON OXYSULFIDE IN WATER.**

(Winkler, 1906.)

t°.	β.	g.	t°.	β.	g.
0	1.333	0.356	20	0.561	0.14
5	1.056	0.281	25	0.468	0.11
10	0.836	0.221	30	0.403	0.10
15	0.677	0.179			

For β and g see Carbon Dioxide, p. 227.

**SOLUBILITY OF CARBON OXYSULFIDE IN SEVERAL SOLVENTS**

Solvent.	t°.	cc. COS per 100 cc. Solvent.	A
Water	13.5	80	(Hempel
"	20	54	(Stock a
Alcohol	22	800	"
Toluene	22	1500	"
HCl solution of CuCl	13.5	20	(Hempel
1 gm. KOH + 2cc. H <sub>2</sub> O + 2cc. C <sub>2</sub> H <sub>5</sub> OH	13.5	7200	"
Pyridine	...	4.4	"
Nitrobenzene	...	12.0	"



SOLUBILITY OF CARBON TETRACHLORIDE  $\text{CCl}_4$ .

SOLUBILITY IN WATER. (Rees, 1906.)

$^{\circ}\text{C}$ .	$0^{\circ}$ .	$10^{\circ}$ .	$20^{\circ}$ .	$30^{\circ}$ .
g. $\text{CCl}_4$ per 100 gms. $\text{H}_2\text{O}$	0.097	0.083	0.080	0.085

RECIPROCAL SOLUBILITY OF CARBON TETRACHLORIDE, ALCOHOL AND WATER.  
(Curtis and Titus, 1915.)

Alcohol was added from a weight buret to mixtures of weighed amounts of  $\text{CCl}_4$  and  $\text{H}_2\text{O}$ , stirred vigorously at  $19.75^{\circ}$ , until the mixture became homogeneous.

Per cent $\text{CCl}_4$	Per cent $\text{C}_2\text{H}_5\text{OH}$	Per cent $\text{H}_2\text{O}$
41.94	43.19	14.89
33.07	47.68	19.25
25.46	50.50	24.04
17.00	51.95	31.05
14.02	51.56	34.42
10.53	50.97	38.50

In order to determine the effect of temperature upon the mutual solubility, one component was added to a known mixture of the other two, and the critical solubility temperature determined by raising and lowering the temp. through the critical point several times. A further amount of the third component was then added and the critical solubility temperature again determined.

$\frac{\text{CCl}_4}{\text{C}_2\text{H}_5\text{OH}} = 0.5048$		Ratio $\frac{\text{CCl}_4}{\text{C}_2\text{H}_5\text{OH}} = 1.064$		Ratio $\frac{\text{CCl}_4}{\text{C}_2\text{H}_5\text{OH}} = 2.1012$		Ratio $\frac{\text{CCl}_4}{\text{H}_2\text{O}} = 1.0922$	
Conc. $\text{CCl}_4$	Crit. Sol. $^{\circ}\text{C}$ .	Per cent $\text{H}_2\text{O}$	Crit. Sol. $^{\circ}\text{C}$ .	Per cent $\text{H}_2\text{O}$	Crit. Sol. $^{\circ}\text{C}$ .	Per cent $\text{C}_2\text{H}_5\text{OH}$	Crit. Sol. $^{\circ}\text{C}$ .
.25	-1.8	12.47	2.03	6.84	12.7	47.43	44.5
.61	+3.6	13.95	23.9	7.16	21.55	47.83	39.5
.13	10.6	14.45	29.8	7.35	27.2	48.6	30.6
.64	17	14.85	35.4	7.54	31.3	49.61	19.9
.14	24.5	15.3	39.55	7.84	36.8	50.07	14.6
.15	31.45	15.67	42.75	8.02	39.75	50.50	9.15
.52	35.5(?)	16.02	45.5	8.28	44.1	51.06	1.6

The results show that temperature has very little effect on the mutual solubility of the three components. Extensive series of determinations of refractive indices and densities of the mixtures are also given.

Freezing-point data for  $\text{CCl}_4 + \text{Cl}$  are given by Waentig and McIntosh (1916).

## MIXTURE.

100 gms. $\text{H}_2\text{O}$	dissolve 0.13 gm. carmine at $20-25^{\circ}$ .	(Dehn, 1917.)
" pyridine	" 3.34 gms.	"
" 50% aq. pyridine	" 2.03 "	"

CARVACROL  $(\text{CH}_3)_2\text{CH}.\text{C}_6\text{H}_4(\text{CH}_3).\text{OH}$ .

## MISCIBILITY OF AQUEOUS ALKALINE SOLUTIONS OF CARVACROL WITH SEVERAL ORGANIC COMPOUNDS INSOLUBLE IN WATER. (Sheuble, 1907.)

To 5 cc. portions of aq. KOH solution (250 gms. per liter) were added the given amounts of the aq. insoluble compound from a buret and then the carvacrol, drop by drop until solution occurred. Temperature not stated.

## Composition of Homogeneous Solutions.

Aq. KOH.	Aq. Insol. Compd.	Carvacrol.
5 cc.	2 cc. (= 1.64 gms.) Octyl(1) Alcohol	1.8 gms.
5 "	5 cc. (= 4.1 gms.) "	2.6 "
5 "	2 cc. (= 1.74 gms.) Toluene	4 "
5 "	3 cc. (= 2.61 gms.) "	4.8 "
5 "	2 cc. (= 1.36 gms.) Heptane	4.6 "

(1) = the normal secondary octyl alcohol, i.e., the so-called capryl alcohol,  $\text{CH}_3(\text{CH}_2)_6.\text{CH}(\text{OH})\text{CH}_3$ .



## CARVOXIME

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### CARVOXIME $C_{10}H_9NOH$ *d*, *l* and *i*.

SOLUBILITY IN AQUEOUS ALCOHOL OF  $d_{17.5} = 0.9125$  (51.6 PER CENT  $C_2H_5OH$ ). (Goldschmidt and Cooper, 1898.)

The determinations were made by the synthetic method. On account of the slow rate at which melted carvoxime solidified on cooling below the melting point, in the tubes containing the synthetic mixtures, it was possible to obtain results which show the solubility curve for liquid carvoxime, in addition to the curves for dextro and inactive carvoxime. The curves for these latter intersect the curve for liquid carvoxime respectively at 51.7°, the m. pt. of dextro, and 70.5° the m.pt. of inactive carvoxime.

Gms. Carvoxime.	Gms. Solvent.	Mols. Carvoxime per 100 Gms. Solvent.	t° of Solution.		Solid Phase.
			Solid.	Liquid.	
0.0668	1.0868	0.0373	38.4	13.9	<i>d</i> Carvoxime
0.1232	1.0830	0.0689	45.8	31.9	"
0.2026	1.0218	0.1202	50.3	49.8	"
0.4040	1.0218	0.2396	...	79.6	"
0.4128	0.8130	0.3077	...	94.5	"
0.0657	1.0980	0.0363	54.2	...	<i>i</i> Carvoxime
0.1212	1.0161	0.0723	62.5	33.7	"
0.2715	1.0129	0.1625	69.25	61.3	"
0.3755	1.0384	0.2192	...	76.6	"
0.4496	0.7768	0.3409	...	102.9	"

### SOLUBILITY IN *d* LIMONENE. (Goldschmidt and Cooper, 1898.)

t°.	Gms. $C_{10}H_{16}NOH$ per 100 Gms. <i>d</i> Limonene.	Solid Phase.	t°.	Gms. $C_{10}H_{16}NOH$ per 100 Gms. <i>d</i> Limonene.	Solid Phase.
24.6	44.6	<i>l</i> Carvoxime	48	198.7	<i>l</i> Carvoxime
30	59.2	<i>l</i> "	49.4	199.7	<i>d</i> "
30.3	63.3	<i>d</i> "	55.1	325.1	<i>l</i> "
38.4	104.3	<i>l</i> "	55.9	346.6	<i>d</i> "
39.3	103.1	<i>d</i> "	58.8	560	<i>d</i> "
43.1	130.8	<i>l</i> "	63.2	1269.3	<i>d</i> "

Freezing-point data are given for mixtures of *d* and *l* carvoxime by Adriani, 1900 and by Beck, 1904.

## CASEIN.

100 gms.  $H_2O$  dissolve 2.01 gms. casein at 20–25°. (Dehn, 1917.)

100 gms. pyridine dissolve 0.09 gm. casein at 20–25°.

100 gms. aq. 50% pyridine dissolve 0.56 gm. casein at 20–25°.

Data for the solubility of casein in aqueous NaCl solutions are given by Ryd (1917). An abstract of experiments on the solubility of casein in dilute acids is given by Van Slyke and Winter (1913). Results for the solubility of casein in aqueous solutions of KOH, LiOH and  $Ca(OH)_2$  at various temperatures, are given by Robertson, 1908.

## CATECHOL $o$ $C_6H_4(OH)_2$ .

Freezing-point data (solubilities, see footnote, p. 1) are given for mixtures of catechol and picric acid, catechol and  $\alpha$  naphthylamine and catechol and *p* toluidine by Philip and Smith, 1905.

## CEPHAELINE Salts.

SOLUBILITY IN WATER. (Carr and Pyman, 1914.)

Salt.	Formula.	t°.	Gms. Hydrated Salt per 100 cc. Sat. Sol.
Cephaeline Hydrochloride	$C_{22}H_{38}O_4N_2 \cdot 2HCl \cdot 7H_2O$	17–18	26.5
" acid "	$C_{22}H_{38}O_4N_2 \cdot 5HCl$	18	about 50
" Hydrobromide	$C_{22}H_{38}O_4N_2 \cdot 2HBr \cdot 7H_2O$	17–18	5.4 (dried at 100°)



**CERIUM ACETATE, BUTYRATE, FORMATE, etc.****SOLUBILITY IN WATER.**

(Wolff — Z. anorg. Chem. 45, 102, '05.)

Salt.	Formula.	Grams Anhydrous Salt per 100 Gms. Solution at		
		11°.	15°.	76°.
Acetate	$\text{Ce}(\text{C}_2\text{H}_3\text{O}_2)_3 \cdot 1\frac{1}{2}\text{H}_2\text{O}$	...	19.61	12.97
Butyrate	$\text{Ce}(\text{C}_4\text{H}_7\text{O}_2)_3$ and $3\text{H}_2\text{O}$	3.544	3.406	1.984
Iso Butyrate	$\text{Ce}(\text{C}_4\text{H}_7\text{O}_2)_3 \cdot 3\text{H}_2\text{O}$	...	6.603 (20.4°)	3.39
Formate	$\text{Ce}(\text{CHO}_2)_3$	...	0.398 (13°)	0.374 (75.3°)
Propionate	$\text{Ce}(\text{C}_3\text{H}_5\text{O}_2)_3 \cdot \text{H}_2\text{O}$ , and $3\text{H}_2\text{O}$	...	18.99	15.93

**CERIUM AMMONIUM NITRATE (Ceri)  $\text{Ce}(\text{NO}_3)_4 \cdot 2\text{NH}_4\text{NO}_3$** **SOLUBILITY IN WATER.**

(Wolff.)

t°.	Gms. per 100 Gms. Solution.		Atomic Relation.	Gms. $\text{Ce}(\text{NO}_3)_4 \cdot 2\text{NH}_4\text{NO}_3$ per 100 Gms.	
	$\text{NH}_4$ .	Ce.		Solution.	Water.
25	4.065	15.16	2.08 : 1	58.49	140.9
35.2	4.273	16.10	2.06 : 1	61.79	161.7
45.3	4.489	16.65	2.08 : 1	64.51	174.9
64.5	4.625	{ 17.40 Ce 15.03 Ce IV	2.06 : 1 Ce 2.39 : 1 Ce IV	66.84	201.6
85.6	4.778	{ 18.16 Ce 15.79 Ce IV	2.04 : 1 Ce 2.34 : 1 Ce IV	69.40	226.8
112	6.117	{ 22.82 Ce 16.22 Ce IV	2.08 : 1 Ce 2.95 : 1 Ce IV	88.03	735.4

**CERIUM AMMONIUM NITRATE (Cero)  $\text{Ce}(\text{NO}_3)_3 \cdot 2\text{NH}_4\text{NO}_3 \cdot 4\text{H}_2\text{O}$** **SOLUBILITY IN WATER.**

(Wolff.)

t°.	Gms. per 100 Gms. Solution.		Atomic Relation.	Gms. $\text{Ce}(\text{NO}_3)_3 \cdot 2\text{NH}_4\text{NO}_3$ per 100 Gms.	
	$\text{NH}_4$ .	Ce.		Solution.	Water.
8.75	4.787	18.56	1.999 : 1	70.2	235.5
25.0	5.09	19.80	1.995 : 1	74.8	296.8
45.0	5.53	21.06	2.037 : 1	80.4	410.2
60.0	6.01	22.77	2.054 : 1	87.2	681.2
65.06	6.11	23.42	2.022 : 1	89.1	817.4

**CERIUM AMMONIUM SULPHATE  $\text{Ce}_2(\text{SO}_4)_3 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 8\text{H}_2\text{O}$** **SOLUBILITY IN WATER.**

(Wolff.)

t°.	Gms. $\text{Ce}_2(\text{SO}_4)_3 \cdot (\text{NH}_4)_2\text{SO}_4$ per 100 Gms. Solution.		Solid Phase.	t°.	Gms. $\text{Ce}_2(\text{SO}_4)_3 \cdot (\text{NH}_4)_2\text{SO}_4$ per 100 Gms. Solution.		Solid Phase.
	Solution.	Water.			Solution.	Water.	
22.3	5.06	5.33	$\cdot 8\text{H}_2\text{O}$	45.0	2.91	2.99	Anhydride
35.1	4.93	5.18	"	55.25	2.16	2.21	"
45.2	4.76	4.99	"	75.4	1.46	1.48	"
				85.2	1.17	1.18	"



**CEROUS CHLORIDE**

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**CEROUS CHLORIDE**  $\text{CeCl}_3$ .

100 cc. anhydrous hydrazine dissolve 3 gms.  $\text{CeCl}_3$ , with evolution of gas, at room temp. (Welsh and Broden, 1914)

**CERIUM CITRATE**  $2(\text{CeC}_6\text{H}_5\text{O}_7) \cdot 7\text{H}_2\text{O}$ .

100 gms. of aq. citric acid solution containing 10 gms. citric acid per 100 dissolve 0.3 gm.  $\text{Ce}(\text{C}_6\text{H}_5\text{O}_7)$  at  $20^\circ$ . (Holmberg, 1907)

**CERIUM COBALTICYANIDE**  $\text{Ce}_2(\text{CoC}_6\text{N}_6)_3 \cdot 9\text{H}_2\text{O}$ .

100 gms. aq. 10%  $\text{HCl}$  ( $d_{18} = 1.05$ ) dissolve 1.075 gms. of the salt at  $25^\circ$ . (James and Willard, 1906)

**CERIUM FLUORIDE**  $\text{CeF}_3$ .

Freezing-point lowering data are given for mixtures of  $\text{CeF}_3 + \text{KF}$  by Pusch in and Baskow, 1913.

**CERIUM GLYCOLATE**  $\text{Ce}(\text{C}_2\text{H}_3\text{O}_3)_3$ .

One liter  $\text{H}_2\text{O}$  dissolves 3.563 gms. of the salt at  $20^\circ$ . (Jantsch and Grunkraut, 1912)

**CERIUM IODATE**  $\text{Ce}(\text{IO}_3)_3$ .

One liter sat. aqueous solution contains 1.456 gms.  $\text{Ce}(\text{IO}_3)_3$ , determined by a chemical method, and 1.636 gms. determined electrolytically. (Rimbach and Schubert, 1909)

**CERIUM MALONATE**  $\text{Ce}_2(\text{C}_2\text{H}_3\text{O}_4)_3 + 6\text{H}_2\text{O}$ .

Solvent.	gms. $\text{Ce}_2(\text{C}_2\text{H}_3\text{O}_4)_3$ per 100 Grams. Solvent.
Aq. Ammonium Malonate, containing 10 gms. per 100 cc.	20 0.2
Aq. Malonic Acid, containing 20 gms. per 100 cc.	20 0.6

(Holmberg, 1907)

**CERIUM** Magnesium, etc., **NITRATES**.

SOLUBILITY IN CONC. Aq.  $\text{HNO}_3$  ( $d_{18} = 1.325 = 51.59$  Gms.  $\text{HNO}_3$  per 100 cc.) at  $15^\circ$ . (Jantsch, 1912.)

Cerium magnesium nitrate, 1 liter sat. solution contains 58.5 gms.  $[\text{Ce}(\text{NO}_3)_6] \cdot \text{Mg}_3 \cdot 24\text{H}_2\text{O}$ .

" nickel	"	"	"	75.3	"	"	$\text{Ni}_3$	"
" cobalt	"	"	"	103.3	"	"	$\text{Co}_3$	"
" zinc	"	"	"	111.7	"	"	$\text{Zn}_3$	"
" manganese	"	"	"	178.8	"	"	$\text{Mn}_3$	"

**CERIUM OXALATE**  $\text{Ce}_2(\text{C}_2\text{O}_4)_3 \cdot 9\text{H}_2\text{O}$ .

One liter  $\text{H}_2\text{O}$  dissolves 0.00041 gm.  $\text{Ce}_2(\text{C}_2\text{O}_4)_3$  at  $25^\circ$ , determined by the electrolytic method. (Rimbach and Schubert, 1909.)

**SOLUBILITY OF CERIUM OXALATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID AND OF OXALIC ACID AT  $25^\circ$ .**  
(Hauser and Wirth, 1908; Wirth, 1912.)

Conc. of Aqueous Acid.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.	Conc. of Aq. Acid.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
	$\text{CeO}_3 = \text{Ce}_2(\text{C}_2\text{O}_4)_3$			$\text{CeO}_3 = \text{Ce}_2(\text{C}_2\text{O}_4)_3$	
0.1% $\text{H}_2\text{SO}_4$	0.0136	0.0215 $\text{Ce}(\text{C}_2\text{O}_4)_3 \cdot 9\text{H}_2\text{O}$	0.1% $(\text{COOH})_2$	0.0020	0.0032 $\text{Ce}_2(\text{C}_2\text{O}_4)_3 \cdot 9\text{H}_2\text{O}$
0.5 "	0.0524	0.0828 "	0.5 "	0.0083	0.0131 "
1.0 "	0.114	0.1802 "	1.0 "	0.0040	0.0063 "
1.445 "	0.1764	0.2788 "	3.2 " (sat.)	0.0019	0.0030 "
2.39 "	0.3083	0.4871 "	0.05 " + 0.05% $\text{H}_2\text{SO}_4$	0.0030	0.0047 "
2.9 "	0.4724	0.7467 "	0.05 " + .5 "	0.0025	0.0039 "
3.9 "	0.6300	0.9957 "	0.25 " + .25 "	0.0046	0.0073 "
4.32 "	0.7502	1.1860 "	0.50 " + .05 "	0.0105	0.0166 "
5.3 "	0.9019	1.4250 "	0.50 " + .50 "	0.0010	0.0016 "

**CERIUM** Dimethyl **PHOSPHATE**  $\text{Ce}_2[(\text{CH}_3)_2\text{PO}_4]_3 \cdot \text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 79.6 gms.  $\text{Ce}_2[(\text{CH}_3)_2\text{PO}_4]_3$  at  $25^\circ$  and about 65 gms. at  $95^\circ$ . (Morgan and James, 1914.)



BIUM SELENATE  $\text{Ce}_2(\text{SeO}_4)_3 \cdot 11\text{H}_2\text{O}$ .

SOLUBILITY IN WATER. (Cingolani, 1908.)

t°.	Gms. $\text{Ce}_2(\text{SeO}_4)_3$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Ce}_2(\text{SeO}_4)_3$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
	39.55	$\text{Ce}_2(\text{SeO}_4)_3 \cdot 12\text{H}_2\text{O}$	60	13.68	$\text{Ce}_2(\text{SeO}_4)_3 \cdot 8\text{H}_2\text{O}$
.6	37.0	"	60.8	13.12	"
.6	36.9	$\text{Ce}_2(\text{SeO}_4)_3 \cdot 11\text{H}_2\text{O}$	78.2	5.53	"
	33.84	"	80.5	4.56	$\text{Ce}_2(\text{SeO}_4)_3 \cdot 7\text{H}_2\text{O}$
.8	33.22	"	91	2.02	"
.2	33.15	$\text{Ce}_2(\text{SeO}_4)_3 \cdot 10\text{H}_2\text{O}$	95.4	1.536	$\text{Ce}_2(\text{SeO}_4)_3 \cdot 4\text{H}_2\text{O}$
	32.16	"	98	1.785	"
.9	31.89	"	100	2.513	"

BIUM SULFATE  $\text{Ce}_2(\text{SO}_4)_3$ .

SOLUBILITY OF THE SEVERAL HYDRATES IN WATER.

appel, 1904; the previous determinations by Muthman and Rolig, 1898, and by Wyronhoff, 1901, now by Koppel to be inaccurate.)

Gms. $\text{Ce}_2(\text{SO}_4)_3$ per 100 Gms. Solution.	Mols. $\text{Ce}_2(\text{SO}_4)_3$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Ce}_2(\text{SO}_4)_3$ per 100 Gms. Solution.	Mols. $\text{Ce}_2(\text{SO}_4)_3$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
14.20	0.525	$\text{Ce}_2(\text{SO}_4)_3 \cdot 12\text{H}_2\text{O}$	20.5	8.69	0.302	$\text{Ce}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$
8 14.91	0.555	"	40	5.613	0.188	"
2 15.04	0.561	"	60	3.88	0.120	"
17.35	0.665	$\text{Ce}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$	45	8.116	0.280	$\text{Ce}_2(\text{SO}_4)_3 \cdot 5\text{H}_2\text{O}$
10.61	0.376	"	60	3.145	0.103	"
8.863	0.308	"	80	1.19	0.0382	"
6 6.686	0.227	"	100.5	0.46	0.0149	"
6 4.910	0.164	"	35	7.8	0.27	$\text{Ce}_2(\text{SO}_4)_3 \cdot 4\text{H}_2\text{O}$
4.465	0.148	"	40	5.71	0.19	"
3.73	0.123	"	50	3.31	0.11	"
3.47	0.114	"	65	1.85	0.06	"
15.95	0.605	$\text{Ce}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$	82	0.98	0.032	"
9.95	0.350	"	100.5	0.42	0.014	"

SOLUBILITY OF CERIUM SULFATE IN AQUEOUS SOLUTIONS OF ALKALI SULFATES. (Barre, 1910.)

In aq. sols. of $\text{K}_2\text{SO}_4$ at 16°.		In aq. sols. of $\text{Na}_2\text{SO}_4$ at 19°.		In aq. sols. of $(\text{NH}_4)_2\text{SO}_4$ at 16°.	
Gms. per 100 Gms. $\text{H}_2\text{O}$ .	$\text{Ce}_2(\text{SO}_4)_3$ .	Gms. per 100 Gms. $\text{H}_2\text{O}$ .	$\text{Ce}_2(\text{SO}_4)_3$ .	Gms. per 100 Gms. $\text{H}_2\text{O}$ .	$\text{Ce}_2(\text{SO}_4)_3$ .
60.	10.747	$\text{Na}_2\text{SO}_4$	9.648	$(\text{NH}_4)_2\text{SO}_4$	10.747
178	0.956	0	0.637	0	1.026
510	0.432	0.328	0.259	3.464	0.782
726	0.250	0.684	0.0937	9.323	0.748
290	0.042	1.091	0.0570	19.240	0.701
	6.949 (at 33°)	1.392	0.0303	29.552	0.497
		1.699	0.0120	45.616	0.194
		2.640	0.0065	55.083	0.090
		3.589	0.0046	63.920	0.035
		5.660	0.0037	72.838	

the following double salts were found.  $\text{Ce}_2(\text{SO}_4)_3 \cdot \text{K}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$ ,  $2\text{Ce}_2(\text{SO}_4)_3 \cdot \text{O}_4 \cdot 8\text{H}_2\text{O}$ ,  $\text{Ce}_2(\text{SO}_4)_3 \cdot 5\text{K}_2\text{SO}_4$ ,  $\text{Ce}_2(\text{SO}_4)_3 \cdot \text{Na}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$ ,  $\text{Ce}_2(\text{SO}_4)_3 \cdot (\text{NH}_4)_2\text{SO}_4$  and  $\text{Ce}_2(\text{SO}_4)_3 \cdot 5(\text{NH}_4)_2\text{SO}_4$ .



## CERIUM SULFATE

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### SOLUBILITY OF CERIUM SULFATE IN AQ. SOLUTIONS OF SULFURIC ACID AT 25° (Wirth, 1912.)

Normality of Aq. H <sub>2</sub> SO <sub>4</sub> .	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Normality of Aq. H <sub>2</sub> SO <sub>4</sub> .	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	CeO <sub>2</sub>	= Ce <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>			CeO <sub>2</sub>	= Ce <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	
0.0	4.604	7.60	Ce <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·8H <sub>2</sub> O	4.32	2	3.301	Ce <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·8H <sub>2</sub> O
0.1	4.615	7.618	"	6.685	0.9115	1.505	"
1.1	3.64	6	"	9.68	0.4439	0.733	"
2.16	3.04	5.018	"	15.15	0.145	0.239	"

## CERIUM SULFONATES.

SOLUBILITY IN WATER. (Holmberg, 1907; Katz and James, 1913.)

Name.	Formula.	t°.	Gms. Anhydrous Salt per 100 Gms. H <sub>2</sub> O.
Cerium <i>m</i> Nitrobenzene Sulfonate	Ce[C <sub>6</sub> H <sub>4</sub> (NO <sub>2</sub> )SO <sub>3</sub> ] <sub>3</sub> ·6H <sub>2</sub> O	15	25.5
Cerium Bromonitrobenzene Sulfonate	Ce[C <sub>6</sub> H <sub>3</sub> Br(NO <sub>2</sub> )SO <sub>3</sub> ] <sub>2</sub> ·4.2H <sub>2</sub> O	25	5.89

## CERIUM TARTRATE Ce<sub>2</sub>(C<sub>4</sub>H<sub>4</sub>O<sub>6</sub>)<sub>3</sub>·4½H<sub>2</sub>O, also 6H<sub>2</sub>O.

SOLUBILITY IN WATER (Rimbach and Shubert, 1909, by electrolytic method)  
AND IN AQ. SOLUTIONS. (Holmberg, 1907.)

Solvent.	t°.	Gms. Anhydrous Salt per 100 Gms. Sat. Sol.	Solid Phase.
Water	25	0.005	Ce <sub>2</sub> (C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> ) <sub>3</sub> ·4½H <sub>2</sub> O
Aq. Am. Tartrate, 10 Gms. per 100 cc.	20	0.7	Ce <sub>2</sub> (C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> ) <sub>3</sub> ·6H <sub>2</sub> O
Aq. Am. Tartrate, 20 Gms. per 100 cc.	20	2	"
Aq. Tartaric Acid, 20 Gms. per 100 cc.	20	0.4	"
Aq. Tartaric Acid, 40 Gms. per 100 cc.	20	0.2	"

## CERIUM TUNGSTATE Ce<sub>2</sub>(WO<sub>4</sub>)<sub>3</sub>.

Freezing-point lowering data for mixtures of Ce<sub>2</sub>(WO<sub>4</sub>)<sub>3</sub> and PbWO<sub>4</sub> are given by Zambonini, 1913.

## CETYL ALCOHOL C<sub>16</sub>H<sub>33</sub>OH.

100 gms. methyl alcohol dissolve	96.9 gms. C <sub>16</sub> H <sub>33</sub> OH at 23.9°.	(Timofeev, 1899)
" ethyl "	102.2 "	"
" " "	410 "	"
" propyl "	405 "	"

## CHLORAL HYDRATE CCl<sub>3</sub>CHO·H<sub>2</sub>O.

SOLUBILITY IN WATER, ETHYL ALCOHOL, CHLOROFORM, AND IN TOLUENE.  
(Speyers, 1902.)

Calculated from the original results, which are given in terms of gram molecules of chloral hydrate per 100 gram mols. of solvent.

t°.	In Water.		In Alcohol.		In Chloroform.		In Toluene.	
	W.	S.	W.	S.	W.	S.	W.	S.
0	1.433	189.7	1.11	123.3	1.530	3.7	0.898	3.2
5	1.460	233.0	1.16	130.0	1.515	4.0	0.900	4.0
10	1.485	275.0	1.23	140.0	1.510	5.0	0.910	7.0
15	1.510	330.0	1.30	160.0	1.505	9.0	0.915	11.0
20	1.535	383.0	1.36	185.0	1.510	19.0	0.94	21.0
25	1.555	433.0	1.42	215.0	1.520	34.0	0.97	36.0
30	1.580	480.0	1.49	245.0	1.540	56.0	1.02	56.0
35	1.59	516.0	1.55	280.0	1.570	80.0	1.13	80.0
40	1.605	...	1.60	320.0	1.590	110.0	1.40	110.0
45	1.620	...	...	...	...	...	...	...

W = wt. of 1 cc. saturated solution, S = Gms. C<sub>2</sub>HCl<sub>3</sub>·H<sub>2</sub>O per 100 grams solvent.



## SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. $\text{CCl}_3\text{COH.H}_2\text{O}$ per 100 Gms. Solvent.	Solvent.	t°.	Gms. $\text{CCl}_3\text{COH.H}_2\text{O}$ 100 Gms. Solvent.
% Aq. Pyridine	20-25	374 (Dehn, 1917.)	Ether	ord. t.	200 (Squires.)
Pyridine	20-25	80.9	Oil tur-	{ cold	10 "
Carbon Disulfide	ord. t.	1.47 (Squires.)	pentine	{ hot	20 "
Glycerol	ord. t.	200 "	Olive Oil	ord. t.	100 "

Freezing-point data (solubility, see footnote, p. 1) are given for mixtures of chloral and water by van Rossem (1908); for mixtures of chloral and ethyl alcohol by Leopold (1909); for mixtures of chloral hydrate and menthol by Pawlewski (1913) and for mixtures of chloral hydrate and salol by Bellucci (1912, 1913).

## DISTRIBUTION OF CHLORAL HYDRATE BETWEEN WATER AND ORGANIC SOLVENTS.

Immiscible Solvents.	t.	Dist. Coef.	Conc. in $\text{H}_2\text{O}$ Conc. in Org. Solvent.	Authority.
Water and Ether	0-30°		0.235	(Hantzsch and Vagt, 1901.)
Water and Benzene	...		...	(Bubanovic, 1913.)
Water and Olive Oil	ord.		4.9	(Baum, 1899.)
" " "	30°		4.3	(Meyer, 1901; 1909.)
" " "	3		16.7	(Meyer, 1901.)
" " Toluene	0-20°		58-74.5	(Hantzsch and Vagt, 1901.)

CHLORAL FORMAMIDE  $\text{CCl}_3\text{CH(OH).NH.CHO}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 5.3 gms.  $\text{CCl}_3\text{CH(OH).NHCHO}$  at 25°. (U. S. P.)  
 100 gms. 95% alcohol dissolve 77 gms.  $\text{CCl}_3\text{CH(OH).NHCHO}$  at 25°. "

CHLORINE  $\text{Cl}_2$ .

## SOLUBILITY IN WATER.

(Winkler, 1912; Roozeboom, 1884, 1885, 1888.)

t°.	$\beta$ .	g.	t°.	Gms. $\text{Cl}$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
0	4.610	1.46	-0.24	0.492	Ice + $\text{Cl}$ .8 aq.
3	3.947	1.25	0	0.507-0.560	$\text{Cl}$ .8 aq.
6	3.411	1.08	2	0.644	"
9	3.031	0.96	4	0.732	"
9.6	2.980	0.94	6	0.823	"
12	2.778	0.88	8	0.917	"
10	3.095	0.980	9	0.965-0.908	"
15	2.635	0.835	20	1.85	"
20	2.260	0.716	28.7	3.69	" + 2 layers
25	1.985	0.630			
30	1.769	0.562			
40	1.414	0.451			
50	1.204	0.386			
60	1.006	0.324			
70	0.848	0.274			
80	0.672	0.219			
90	0.380	0.125			
100	c	0			

$\beta$  = vol. of  $\text{Cl}_2$  (reduced to 0° and 760 mm.) absorbed by 1 vol.  $\text{H}_2\text{O}$  at total pressure of 760 mm.

g = Gms.  $\text{Cl}$  per 100 gms.  $\text{H}_2\text{O}$  at a total pressure of 760 mm.

The coefficient of solubility of chlorine at 15°, determined by an aspiration method, is given as 51.7 for carbon tetrachloride, 39.6 for acetic anhydride, 36.7 for 99.84% acetic acid, 25.3 for 90 vol. % acetic acid, 16.43 for 75 vol. % acetic acid and 13.43 for 65 vol. % acetic acid. (Jones, 1911.)



## SOLUBILITY IN WATER.

(Goodwin, 1882.)

The saturated aqueous solution of the chlorine was cooled until chlorine hydrate separated; the temperature was then gradually raised and portions withdrawn for analysis at intervals. The chlorine was determined by iodometric titration and the results calculated to volume of chlorine dissolved by unit volume of solvent at the given temperature and 760 mm. pressure. Slightly different results were obtained for solutions in contact with much, little, or no chlorine hydrate. The following results are taken from an average curve:

t°.	Solubility Coefficient.	t°.	Solubility Coefficient.	t°.	Solubility Coefficient.
2.5	1.76	11	3	25	2.06
5	2	12.5	2.75	30	1.8
7.5	2.25	15	2.6	40	1.35
10	2.7	20	2.3	50	1

## SOLUBILITY OF CHLORINE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AND OF POTASSIUM CHLORIDE.

(Goodwin.)

t°.	Coefficient of Solubility in:				Results at 21°.	
	HCl. (1.046 Sp. Gr.).	HCl (1.08 Sp. Gr.).	HCl (1.125 Sp. Gr.).	KCl (20 g. per 100 cc.)	Gms. HCl per 1000 cc.	Solubility of Cl. (Ostwald I, see p. 227-)
0	4.1	6.4	7.3	1.5	0.	2.2799
5	5.1	5.2	6.7	2	3.134	1.6698
10	4.1	4.5	6.1	2.2	9.402	1.5013
15	3.5	3.9	5.5	1.6	12.540	1.5292
20	3	3.4	4.7	1.2	31.340	1.8033
25	2.5	3	4	1	125.360	2.4473
30	2	2.4	...	0.9	219.380	3.1312
40	1.25	1.6	...	...	313.401	3.8224

Goodwin also gives results for solutions of NaCl, CaCl<sub>2</sub>, MgCl<sub>2</sub>, SrCl<sub>2</sub>, Fe<sub>2</sub>Cl<sub>3</sub>, CoCl<sub>2</sub>, NiCl<sub>2</sub>, MnCl<sub>2</sub>, CdCl<sub>2</sub>, LiCl, and in mixtures of some of these, but the concentrations of the salt solutions are not stated.

## SOLUBILITY OF CHLORINE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE.

(Kumpf, 1882; Kohn and O'Brien, 1898.)

t°.	Coefficient of Solubility in:			
	9.97% NaCl.	16.01% NaCl.	19.66% NaCl.	26.39% NaCl.
0	2.3	1.9	1.7	0.5
5	2	1.6	1.4	0.44
10	1.7	1.3	1.15	0.4
15	1.4	1.06	0.95	0.36
20	1.2	0.9	0.8	0.34
25	0.94	0.75	0.65	0.3
50	...	...	...	0.2
80	...	...	...	0.05

100 cc. of 6.2 per cent CaCl<sub>2</sub> solution dissolve 0.245 gm. Cl at 12°.

100 cc. of 6.2 per cent MgCl<sub>2</sub> solution dissolve 0.233 gm. Cl at 12°.

100 cc. of 6.2 per cent MnCl<sub>2</sub> solution dissolve 0.200 gm. Cl at 12°.

For coefficient of solubility see p. 227.



Freezing-point data (solubility, see footnote, p. 1) are given for the following mixtures containing chlorine.

Chlorine + Chloroform	(Waentig and McIntosh, 1916.)
" + Ethyl Alcohol	" "
" + Methyl Alcohol	" "
" + Ethyl Acetate	(Waentig and McIntosh, 1916; Maass and McIntosh, 1912.)
" + Methyl Acetate	(Waentig and McIntosh, 1916.)
" + Ether	" "
" + Hydrochloric Acid	(Maass and McIntosh, 1912.)
" + Iodine	(Sturtenbecker, 1888, 1889.)
" + Sulfur	(Ruff and Fischer, 1903.)
" + Sulfur Dioxide	(Smits and Mooy, 1910; Van der Goot, 1913.)
" + Sulfuryl Chloride ( $\text{SO}_2\text{Cl}_2$ )	(Van der Goot, 1913.)
" + " + Sulfur Dioxide	" "
" + Stannic Chloride	(Waentig and McIntosh, 1916.)
" + Toluene	(Waentig and McIntosh, 1916; Maass and McIntosh, 1912.)
" + Nitrosyl Chloride ( $\text{NOCl}$ )	(Boubnoff and Guye, 1911.)

DISTRIBUTION OF CHLORINE BETWEEN  $\text{CCl}_4$  AND GASEOUS PHASE AND BETWEEN  $\text{CCl}_4$  AND WATER.

(Jakowkin, 1899.)

Results for $\text{CCl}_4$ + Gaseous Phase.		Results for dist. between $\text{CCl}_4$ and $\text{H}_2\text{O}$ .			
		1st Series.		2nd Series.	
Millimols Cl per Liter.		Millimols per Liter.		Millimols per Liter.	
		H <sub>2</sub> O Layer.		H <sub>2</sub> O Layer.	
Gaseous Phase.	$\text{CCl}_4$ Phase.	Total Cl.	Unhydrolyzed Cl.	Total Cl.	Unhydrolyzed Cl.
0.1109	8.908	58.21	39.67	803.3	61.73
0.2666	22.46	38.36	22.97	464.6	42.55
0.5365	44.14	23.08	11.12	222.5	26.36
0.8800	75.09	10.10	2.707	52.93	15.24
				21.70	9.94
					202.7

Data for the effect of  $\text{HCl}$  upon the distribution between  $\text{H}_2\text{O}$  and  $\text{CCl}_4$  are also given.

CHLORINE DIOXIDE  $\text{ClO}_2 \cdot 8\text{H}_2\text{O} \pm 1\text{H}_2\text{O}$ .

SOLUBILITY IN WATER.

(Bray, 1905-06.)

t°.	Gms. $\text{ClO}_2$ per Liter.	Solid Phase.	t°.	Gms. $\text{ClO}_2$ per Liter.	Solid Phase.
-0.79	26.98	$\text{ClO}_2 \cdot 8\text{H}_2\text{O} + \text{Ice}$	15.3	87.04	$\text{ClO}_2 \cdot 8\text{H}_2\text{O} \pm 1\text{H}_2\text{O}$
0	27.59	$\text{ClO}_2 \cdot 8\text{H}_2\text{O} \pm 1\text{H}_2\text{O}$	10.7 tr. pt.	107.9	" + liquid $\text{ClO}_2$
1	29.48	"	14	more than > 107.9	liquid $\text{ClO}_2$
5.7	42.10	"	10.7	116.7	"
10	60.05	"	1	more than > 108.6	"

The exact composition of the hydrate could not be determined on account of manipulative difficulties.

Data for the distribution of  $\text{ClO}_2$  between  $\text{H}_2\text{O}$  and  $\text{CCl}_4$  at 0° and 25° are given, also some results showing the effect of  $\text{H}_2\text{SO}_4$ ,  $\text{KClO}_3$  and of  $\text{KCl}$  on this distribution.

CHLORINE MONOXIDE  $\text{Cl}_2\text{O}$ .

100 volumes of water at 0° absorb 200 volumes of  $\text{Cl}_2\text{O}$  gas.

CHLORINE TRIOXIDE  $\text{Cl}_2\text{O}_3$ .

SOLUBILITY IN WATER AT APPROX. 760 MM. PRESSURE.

(Brandan, 1869.)

t°.	8.5°.	14°.	21°.	93°.
Gms. $\text{Cl}_2\text{O}_3$ per 100 gms. $\text{H}_2\text{O}$	4.765	5.012	5.445	5.651

Garzarolli and Thurnbalk, 1881, say that  $\text{Cl}_2\text{O}_3$  does not exist, and above figures are for mixtures of  $\text{Cl}_2\text{O}$  and  $\text{Cl}$ .



# CHLOROFORM

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## CHLOROFORM $\text{CHCl}_3$ .

### SOLUBILITY IN WATER.

(Chancel and Parmentier, 1885; Rex, 1906.)

t°.	Gms. $\text{CHCl}_3$ per Liter of Solution.	Density of Solutions.	t°.	Gms. $\text{CHCl}_3$ per 100 Gms. $\text{H}_2\text{O}$ (Rex).
0	9.87	1.00378	0	1.062
3.2	8.90	...	10	0.895
17.4	7.12	1.00284	20	0.822
29.4	7.05	1.00280	30	0.776
41.6	7.12	1.00284		
54.9	7.75	1.00309		

100 cc.  $\text{H}_2\text{O}$  dissolve 0.42 cc.  $\text{CHCl}_3$  at 22°; Vol. of sol. = 100.39 cc., Sp. Gr. = 1.0002.

100 cc.  $\text{CHCl}_3$  dissolve 0.152 cc.  $\text{H}_2\text{O}$  at 22°; Vol. of sol. = 99.62 cc., Sp. Gr. = 1.4831. (Rex, 1894)

### SOLUBILITY OF CHLOROFORM IN AQUEOUS ETHYL ALCOHOL, METHYL ALCOHOL, AND ACETONE MIXTURES AT 20°.

(Bancroft, 1895.)

In Ethyl Alcohol. Per 5 cc. $\text{C}_2\text{H}_5\text{OH}$ .		In Methyl Alcohol. Per 5 cc. $\text{CH}_3\text{OH}$ .		In Acetone. Per 5 cc. $(\text{CH}_3)_2\text{CO}$	
cc. $\text{H}_2\text{O}$ .	cc. $\text{CHCl}_3$ .	cc. $\text{H}_2\text{O}$ .	cc. $\text{CHCl}_3$ .	cc. $\text{H}_2\text{O}$ .	cc. $\text{CHCl}_3$ .
10	0.20	10	0.10	5	0.16
8	0.3	5	0.48	4	0.22
6	0.515	4	0.8	3	0.33
4	1.13	2	4	2	0.58
2	2.51	1.49	7	1	0.955
1	4.60	1.35	8	0.79	1.12
0.91	5	1.12	10	0.505	1.60
0.76	6			0.30	2.50
0.55	8			0.21	3.50
0.425	10			0.19	4
0.20	20			0.16	5
0.125	30.24			0.12	10

Data for the system chloroform, ethyl ether and water are given by Jüttner, 1901.

Experiments by Schachner (1910) show that various fats (olive oil, sheep and goose fat) in an atmosphere containing 0.55%  $\text{CHCl}_3$  vapor, dissolve 0.96-0.98 per cent  $\text{CHCl}_3$  at 38.5°.

Data for the properties of solutions of  $\text{CHCl}_3$  in water, saline solution, serum, hemoglobin, etc., in their relation to anesthesia are given by Moore and Rossi, (1904) and Waller (1904-05).

Freezing-point lowering data (solubility, see footnote, p. 1) are given for the following mixtures of chloroform and other compounds.

Mixture.	Authority.
Chloroform + Hydrobromic Acid	(Maass and McIntosh, 1912)
" + Hydrochloric Acid	(Baume and Borowski, 1914)
" + Methyl Alcohol	"
" + Methyl Ether	(Baume, 1914, 1909.)
<i>p</i> nitrophenyl chloroform + <i>m</i> nitrophenyl chloroform	(Holleman, 1914.)

## CHOLESTEROL $\text{C}_{27}\text{H}_{48}\text{OH}.\text{H}_2\text{O}$ .

100 gms. $\text{H}_2\text{O}$	dissolve	0.26 gm. cholesterol at 20-25°.	(Deha, 1917)
" pyridine	"	68.10 gms.	" " " "
" 50% aq. pyridine	"	1.10	" " " "
100 cc. $\text{H}_2\text{O}$	dissolve	0.0006 gm. cholesterol-digitonide at b. pt.	(Mueller, 1917)
100 cc. ether	dissolve	0.0007 gm. cholesterol-digitonide at room temp.	"

Freezing-point lowering data (solubility, see footnote, p. 1) are given for mixtures of cholesterol acetate and phytosterol  $\alpha$  and  $\beta$  by Jaeger, 1907. Data for mixtures of cholesterol and oleic acid, cholesterol and palmitic acid and cholesterol and stearic acid are given by Partington, 1911.



# STABILITY OF STEARIC ACID ESTER OF CHOLESTEROL IN OILS AT 37° AND VICE VERSA. (Filehne, 1907.)

terminations were made by adding small weighed amounts of the ester at 60° and cooling to 36–37° while stirring continually. The additions were repeated until a clouding just appeared at 36–37°. In the case of solubility of the oils in cholesterol, the composition of the sat. solution was determined by means of the specific gravity and the melting point.

Solvent.	t° of Clouding.	Gms. Ester per 100 Gms. Oil.	Solute.	Gms. Oil or Acid per 100 Gms. Sat. Solution in Ester, Det. by:	
				Sp. Gr.	M. pt.
Oil	37.6	3.35	Olive Oil	25.5	33.8
Oil	37.6	0.26	Oleic Acid	37	40
Oil	37.5	4.11	Castor Oil	5	1.85
(Oil) Acid	37	0.33	Ricinic Acid	20	16
(Oil) Ricinic Acid	36.2	0.85	Pseudo Ricinic Acid	10	12
(Oil) Crotonic Acid	36.5	0.87	Crotonic Acid	(5)	5

# THE PERCHLORATE and its Nitric Ether.

1 gm. H<sub>2</sub>O dissolve about 290 gms. (CH<sub>3</sub>)<sub>2</sub>N(ClO<sub>4</sub>)CH<sub>2</sub>CH<sub>2</sub>OH at 15°. (Hofmann and Höbhold, 1911.)  
 1 gm. H<sub>2</sub>O dissolve 0.62 gm. (CH<sub>3</sub>)<sub>2</sub>N(ClO<sub>4</sub>)CH<sub>2</sub>CH<sub>2</sub>ONO<sub>2</sub> at 15°.  
 1 gm. H<sub>2</sub>O dissolve 0.82 gm. " " at 20°.

# CHROMIUM ALUMS.

# SOLUBILITY OF CHROMIUM ALUMS IN WATER AT 25°. (Locke, 1901.)

Alum.	Formula.	Per 100 cc. Water.		
		Grams Anhydrous.	Grams Hydrated.	Gram Mols.
Chromium Alum	K <sub>2</sub> Cr <sub>2</sub> (SO <sub>4</sub> ) <sub>4</sub> ·24H <sub>2</sub> O	12.51	24.39	0.0441
Chromium Alum	Te <sub>2</sub> Cr <sub>2</sub> (SO <sub>4</sub> ) <sub>4</sub> ·24H <sub>2</sub> O	10.41	16.38	0.0212

# CHROMIUM CHLORIDES CrCl<sub>3</sub>·6H<sub>2</sub>O.

# SOLUBILITY OF THE GREEN AND THE VIOLET MODIFICATIONS IN WATER AT 25°. (Olie Jr., 1906.)

The solubility of hydrated chromium chloride depends upon the inner composition of the solution, that is, the relative amounts of the green and the violet modification of the salt present in the saturated solution. These are determined by precipitating with silver nitrate. A freshly prepared solution of the green modification yields only one-third of its chlorine in the cold, hence the composition of the violet modification, according to Werner, is represented by the formula [Cr(H<sub>2</sub>O)<sub>4</sub>Cl<sub>2</sub>]. The violet chloride is considered to have the composition, [Cr(H<sub>2</sub>O)<sub>4</sub>Cl<sub>2</sub>]. Determination of the amount of each present involves precipitating one portion of the solution at 0° with silver nitrate and another portion (for total Cl) at the boiling point. Experiments were first made with aqueous solutions of different percentage composition of the two modifications. These were agitated at 25° and analyzed at 25° until equilibrium was reached. The time for equilibrium varied from 18 days according to the concentrations present. The effect of temperature on the presence of HCl on the transition of the green chloride was also studied. Equilibrium in saturated solutions at 25° was determined by rubbing the solid chromium chloride with a little water previously cooled to 0° to a thin slurry. This was then agitated at 25° and portions removed at successive intervals of time and analyzed. The results show the total chloride and per cent as the green modification.

10 Gms. Green Salt + 10 Gms. H <sub>2</sub> O.			25 Gms. Violet Salt + 10 Gms. H <sub>2</sub> O.			25 Gms. Violet Salt + 10 cc. of 35% Sol. of the Green Salt.		
Gms. CrCl <sub>3</sub> per 100 Gms. Sat. Sol.	Per cent of Green Salt.	Time of Agitation.	Gms. CrCl <sub>3</sub> per 100 Gms. Sat. Sol.	Per cent of Green Salt.	Time of Agitation.	Gms. CrCl <sub>3</sub> per 100 Gms. Sat. Sol.	Per cent of Green Salt.	Time of Agitation.
58.36	91.7	1 hr.	61.99	1.53	1 hr.	65.49	15.95	
63.27	75.2	1 day	63.88	8.46	2 days	70.47	26.81	
68.50	62.36	4 days	70.68	30.89	5 "	76.38	39.34	
68.95	57.22	7 "	72.11	37.28	8 "	73.26	34.20	
68.58	57.38	26 "	70.62	51.54	12 "	71.14	58.60	

Later paper Olie Jr. (1907) gives additional results at 29°, 32° and 35°.

anhydr. hydrazine dissolve 13 gms. CrCl<sub>3</sub> at room temp. (Welsh & Broderson, '15.)



**CHROMIUM TRIOXIDE**

250

**CHROMIUM TRIOXIDE**  $\text{CrO}_3$ .**SOLUBILITY IN WATER.**

(Büchner, and Prins, 1912-13; Kremann, Daimler and Bennesch, 1911; Koppel and Blumen and Mylius and Funk, 1900.)

t°.	Gms. $\text{CrO}_3$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{CrO}_3$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{CrO}_3$ per 100 Gms. Sat. Sol.
- 0.9	3.6	Ice	- 43.5	49.1	Ice	50	64.55
- 1.9	7.8	"	- 60	53.3	"	65	64.83
- 3.7	11.5	"	- 155	60.5	" + $\text{CrO}_3$	82	66
- 4.8	14.1	"	- 20	61.7	$\text{CrO}_3$	90	68.5
- 10.95	24.9	"	0	62.24	"	100	67.4
- 11.7	25.2	"	+ 18	62.45	"	115	68.4
- 18.75	33.5	"	24.8	62.88	"	122	70.7
- 25.25	39.2	"	40	63.50		193-196	100 [deco]

Density of solution sat. at 18° = 1.705.

100 cc. anhydrous hydrazine dissolve 1 gm.  $\text{CrO}_3$  with evolution of  
production of a black precipitate at room temp. (Welsh and Broden)**CHROMIUM DOUBLE SALTS.****SOLUBILITY IN WATER.**

(Jørgensen, 1879, 1884, 1890; Struve, 1899.)

Name of Salt.	Formula.	t°.
Chlorotetraamine Chromium Chloride	$\text{CrCl}(\text{NH}_3)_4(\text{OH}_2)\text{Cl}_2$	15
Chloropurpureo Chromium Chloride	$\text{CrCl}(\text{NH}_3)_3\text{Cl}_2$	16
Luteo Chromium Nitrate	$\text{Cr}(\text{NH}_3)_4(\text{NO}_3)_3$	?
Chloropurpureo Chromium Nitrate	$\text{CrCl}(\text{NH}_3)_3(\text{NO}_3)_2$	17.5
Chromic Potassium Molybdate	$3\text{K}_2\text{O} \cdot \text{Cr}_2\text{O}_3 \cdot 12\text{MoO}_3 \cdot 20\text{H}_2\text{O}$	17

**CHROMIUM SULFATES** (ous and ic).**SOLUBILITY IN WATER.**

Salt.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	Authorit
Chromous	12.35 (at 0°)	$\text{CrSO}_4 \cdot 7\text{H}_2\text{O}$	(Moissan, 1
Chromic	120 (at 7°)	$\text{Cr}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$	(Etard, 187

**CHROMIUM THIOCYANATE**  $\text{Cr}(\text{CNS})_3$ .Data for the distribution of  $\text{Cr}(\text{CNS})_3$  between water and ether at 0°  
given by Hantzsch and Vagt, 1901.**CHRYSAROBIN**  $\text{C}_{30}\text{H}_{20}\text{O}_7$ .**SOLUBILITY IN SEVERAL SOLVENTS.**

(U. S. P.)

Solvent.	Gms. per 100 Gms. Solvent at:		Solvent.	Gms. per Solvent
	25°.	80°.		
Water	0.021	0.046	Chloroform	5.
Alcohol	0.324	0.363 (60°)	Ether	0.
Benzene	4	...	Amyl Alcohol	3.
			Carbon Disulfide	0.

**CHRYSENE**  $\text{C}_{18}\text{H}_{12}$ .**SOLUBILITY IN TOLUENE AND IN ABS. ALCOHOL.**

(v. Becchi.)

100 gms. toluene dissolve 0.24 gm.  $\text{C}_{18}\text{H}_{12}$  at 18°, and 5.39 gms. at 100°  
100 gms. abs. alcohol dissolve 0.097 gm.  $\text{C}_{18}\text{H}_{12}$  at 16°, and 0.170 gm. a  
point.



**CINEOLE (Eucalyptole)  $C_{10}H_{18}O$ .**

Freezing-point lowering data (solubility, see footnote, p. 1) for mixtures of cineole and each of the following compounds are given by Bellucci and Grassi, (1913); phenol,  $\alpha$  and  $\beta$  naphthol, *o*, *m* and *p* cresol, *o*, *m* and *p* nitrophenol, *m* amidophenol, pyrocatechol, resorcinol, hydroquinone, guaiacol, *o*, *m* and *p* pybenzoic acid, methyl salicylate, phenyl salicylate, naphthalene and thymol.

**CINCHONA ALKALOIDS.****SOLUBILITY OF CINCHONINE, CINCHONIDINE, QUININE, AND QUINIDINE IN SEVERAL SOLVENTS.** (Müller, 1903; see also Prunier, 1879.)

Grams of the Alkaloid per 100 Grams Solution.

Solvent.	Cinchonine $C_{20}H_{28}N_2O$ .	Cinchonidine $C_{18}H_{26}N_2O$ .	Quinine $C_{20}H_{24}N_2O_3$ .		Quinidine $C_{20}H_{24}N_2O_3$ .
			Hydrate.	Anhydride.	
Ether	0.10	0.211	1.619	0.876	0.776
Ether sat. with $H_2O$	0.123	0.523	5.618	2.794	1.629
$H_2O$ sat. with Ether	0.025	0.0306	0.0667	0.0847	0.031
Benzene	0.0545	0.099	0.2054	1.700	2.451
Chloroform	0.6979	9.301	100+	100+	100+
Acetic Ether	0.0719	0.3003	4.65	2.469	1.761
Petroleum Ether	0.0335	0.0475	0.0103	0.0211	0.0241
Carbon Tetra Chloride	0.0361	0.0508	0.203	0.529	0.565
Water	0.0239	0.0255	0.574	0.0506	0.0202
Glycerine (15.5°)	0.50	...	0.50	...	...

**SOLUBILITY OF CINCHONINE AND CINCHONIDINE IN SEVERAL SOLVENTS.**

Solvent.	t°.	Gms. Alkaloid per 100 Gms. Solvent.		Authority.
		Cinchonine.	Cinchonidine.	
Water	ord. temp.	0.0043	...	(Hatcher, 1902.)
"	20	0.0131	...	(Scholtz, 1912.)
"	25	0.0113	0.021	(Schaefer, 1910.)
Aq. 10% Ammonia	20	0.025	...	(Scholtz, 1912.)
Aq. 85% $C_2H_5OH$ + 10% Am.	20	0.41	...	"
Amine	20	1.6	...	"
Pyridine	20	1.4	7.78	(Scholtz, 1912; Dehn, 1917.)
5% Aq. Pyridine	20-25	...	10	(Dehn, 1917.)
Aq. 85% $C_2H_5OH$ ( $d_{20} = 0.832$ )	20	0.86	...	(Scholtz, 1912.)
$C_2H_5OH$ (95%)	20	0.80	5	(Wherry and Yanovsky, 1918.)
$C_2H_5OH$ (prob. 92.3 wt. %)	25	0.62	5.1	(Schaefer, 1913.)
Abs. $C_2H_5OH$	19	0.874	...	(Timofeiew, 1894.)
Abs. $C_2H_5OH$	25	0.89	...	(Sill, 1905.)
Benzene	25	0.057	0.127	(Schaefer, 1913.)
Acetone	25	0.091	...	(Sill, 1905.)
Chloroform	17	0.014	...	(Oudemans, 1872.)
"	25	0.606	19	(Schaefer, 1913.)
"	50	0.565	...	(Köhler, 1879.)
Ether	25	0.055	...	(Sill, 1905.)
"	32	0.264	...	(Köhler, 1879.)
Isamyl Alcohol	25	1.10	...	(Sill, 1905.)
Isobutyl Alcohol	19	1.09	...	(Timofeiew, 1894.)
Methyl Alcohol	25	0.785-1.17	7.39	(Schaefer, 1913; Sill, 1905.)
Piperidine	20	3.5	...	(Scholtz, 1912.)
Diethyl Amine	20	1.3	...	"

Results for the solubility of cinchonine and cinchonidine in mixtures of ethyl and methyl alcohols with benzene and with chloroform are given by Schaefer (1913).

It is pointed out by Schaefer (1910), that if the saturated solution is analyzed by shaking out with chloroform or ether, variable results, depending on the age and method of manufacture of the alkaloid, will be obtained.

Except in the case of the results by Sill in the above table, the saturated solutions were obtained by agitating at intervals, instead of constantly at the given temperature.



## SOLUBILITY OF CINCHONINE, CINCHONIDINE AND CINCHOTINE SALTS IN WATER.

Salt.	t°.	Gms. per 100 Gms. H <sub>2</sub> O.			Authority.
		Cinchonine Salt.	Cinchonidine Salt.	Cinchotine Salt.	
Hydrobromide	25	1.7	1.66	...	(Schaefer, 1910.)
Bihydrobromide	25	55.5	14.3	...	"
Hydrochloride	25	4.5 <sup>1</sup>	4.8 <sup>2</sup>	2.12 <sup>3</sup>	(Schaefer, 1910; Forst and Böhringer, 1881.)
Bihydrochloride	25	...	62.5	...	(Schaefer, 1910.)
Sulfate	25	1.17 <sup>4</sup>	1.08 <sup>5</sup>	3.28 <sup>6</sup>	(Schaefer, 1910; Forst and Böhringer, 1881.)
Sulfate	80	3.1	4.8	...	(U. S. P.)
Bisulfate	25	66.6	100	...	(Schaefer, 1910.)
Perchlorate	12	0.3 (solvent = aq. 6% HClO <sub>4</sub> )	...	...	(Hofmann, Roth, Höbold and Metzler, 1910.)
Salicylate	25	0.17	0.075	...	(Schaefer, 1910.)
Tannate	25	0.091	0.055	...	"
Tartrate	25	3.12 <sup>7</sup>	...	1.76 <sup>8</sup>	(Schaefer, 1910; Forst and Böhringer, 1881.)
Bitartrate	16	0.99	...	1.28	(Forst and Böhringer, 1881.)
Oxalate	20	0.96	...	1.16	"

<sup>1</sup> 4.16 at 10°. <sup>2</sup> 4 at 15°. <sup>3</sup> at 10°. <sup>4</sup> 1.52 at 13°. <sup>5</sup> 1 at 15°. <sup>6</sup> at 13°. <sup>7</sup> 3 at 16°. <sup>8</sup> at 16°.

## SOLUBILITY OF CINCHONINE SULFATE AND OF CINCHONIDINE SULFATE IN ALCOHOL AND OTHER SOLVENTS.

Solvent.	t°.	Gms. per 100 Gms. Solvent.		Authority.
		(C <sub>20</sub> H <sub>21</sub> N <sub>3</sub> O) <sub>2</sub> ·H <sub>2</sub> SO <sub>4</sub> ·2H <sub>2</sub> O.	(C <sub>20</sub> H <sub>21</sub> N <sub>3</sub> O) <sub>2</sub> ·H <sub>2</sub> SO <sub>4</sub> ·3H <sub>2</sub> O.	
Ethyl Alcohol (92.3 wt. %)	25	9.8 (10)	0.85 (1.4)	(Schaefer, 1913; U. S. P.)
"	60	...	...	(U. S. P.)
Methyl Alcohol	25	83.9	35.9	(Schaefer, 1913; U. S. P.)
Chloroform	25	0.66 (1.45)	0.1 (0.11)	(Schaefer, 1913; U. S. P.)
Ether	25	0.04	0.02	(U. S. P.)
Glycerol	15	6.7	...	"

Results for mixtures of alcohol, chloroform and benzene are given by Schaefer, '13.

Very carefully determined data for the solubility of *Cinchonine* in ethyl alcohol, methyl alcohol, amyl alcohol and acetone solutions of various concentrations of a large number of organic acids and of phenols are given by Sill, 1905.

CINNAMIC ACID C<sub>6</sub>H<sub>5</sub>CH:CH.COOH.

- 100 gms. H<sub>2</sub>O dissolve 0.0495 gm. C<sub>6</sub>H<sub>5</sub>CH:CHCOOH at 25°. (De Jong, 1909.)  
 100 gms. H<sub>2</sub>O dissolve 0.0607 gm. C<sub>6</sub>H<sub>5</sub>CH:CHCOOH at 25°. (Sidgwick, 1910.)  
 100 cc. 0.5 N sodium cinnamate solution dissolve 0.155 gm. C<sub>6</sub>H<sub>5</sub>CH:CHCOOH at 25°. (Sidgwick, 1910.)  
 100 cc. sat. sol. in petroleum ether (b. pt. 30°–70°) contain 0.095 gm. C<sub>6</sub>H<sub>5</sub>CH:CH.COOH at 26°.  
 100 cc. sat. sol. in carbon tetrachloride contain 2.172 gms. C<sub>6</sub>H<sub>5</sub>CH:CH.COOH at 26°. (De Jong, 1909.)  
 100 cc. sat. sol. in 95% formic acid contain 3.76 gms. C<sub>6</sub>H<sub>5</sub>CH:CH.COOH at 26°. (Aschan, 1913.)

## SOLUBILITY OF CINNAMIC ACID (Melting point, 133°) IN ALCOHOLS. (Timofeev, 1904.)

t°.	Gms. Cinnamic Acid per 100 Gms. Sat. Solution in:			
	CH <sub>3</sub> OH.	C <sub>2</sub> H <sub>5</sub> OH.	C <sub>3</sub> H <sub>7</sub> OH.	(CH <sub>3</sub> ) <sub>2</sub> CH.CH <sub>2</sub> OH.
–18	8.1	6.74	4.3	...
–12.5	9.3	8	5.5	...
0	13	11.3	8.2	...
+19.5	22.5	18.1	13.4	8.6

## SOLUBILITY OF CINNAMIC ACID IN ORGANIC SOLVENTS AT 25°. (Herz and Rathmann, 1913.)

Solvent.	Gms. C <sub>6</sub> H <sub>5</sub> CH:CHCOOH per 100 cc. Sat. Sol.	Solvent.		Gms. C <sub>6</sub> H <sub>5</sub> CH:CHCOOH per 100 cc. Sat. Sol.	Solvent.		Gms. C <sub>6</sub> H <sub>5</sub> CH:CHCOOH per 100 cc. Sat. Sol.
		CHCl <sub>3</sub>	CCl <sub>4</sub>		C <sub>2</sub> H <sub>5</sub> Cl	C <sub>2</sub> H <sub>5</sub> Cl	
Chloroform	12.09	100	cc. + 0	cc. 12.09	100	cc. + 0	cc. 6.04
Carbontetrachloride	1.75	80	" + 20	" 9.86	80	" + 20	" 5.91
Trichlorethylene	6.04	50	" + 50	" 6.61	50	" + 50	" 5.85
Tetrachlorethylene	2.55	33.3	" + 66.6	" 4.50	33.3	" + 66.6	" 5.82
Tetrachlorethane	11.05	20	" + 80	" 3.32	20	" + 80	" 5.70
Pentachlorethane	5.54	0	" + 100	" 1.75	0	" + 100	" 5.54



**CINNAMIC ACID**  $C_6H_5CH:CH.COOH$ .

**SOLUBILITY OF CINNAMIC ACID IN AQUEOUS SOLUTIONS OF SODIUM ACETATE, BUTYRATE, FORMATE, AND SALICYLATE AT 26.4°.**  
(Philip—J. Chem. Soc. 87, 992, '05.)

Calculated from the original results, which are given in terms of molecular quantities per liter.

Gms. Na Salt per Liter.	Gms. $C_6H_5CH:CH.COOH$ per Liter in Solutions of:			
	$CH_3COONa$ .	$C_4H_7COONa$ .	$HCOONa$ .	$C_6H_5OH.COONa$ .
0	0.56	0.56	0.56	0.56
1	1.50	1.30	0.92	0.62
2	2.12	1.85	1.12	0.70
3	2.52	2.25	1.27	0.73
4	2.85	2.60	1.40	0.77
5	3.05	2.90	1.47	0.80
8	...	...	...	0.90

1 liter of aqueous solution contains 0.491 gm.  $C_6H_5CH:CH.COOH$  at 25° (Paul).

**SOLUBILITY OF CINNAMIC ACID IN AQUEOUS SOLUTIONS OF ANILIN AND OF PARA TOLUIDIN AT 25°.**  
(Lowenherz—Z. physik. Chem. 25, 394, '98.)

Original results in terms of molecular quantities per liter.

In Aqueous Anilin.		In Aqueous <i>p</i> Toluidin.	
Grams per Liter.		Grams per Liter.	
$C_6H_5NH_2$ .	$C_6H_5CH:CHCOOH$ .	$C_6H_5CH_3NH_2$ .	$C_6H_5CH:CHCOOH$ .
0	0.49	0	0.49
1	1.20	1	1.52
2	1.65	2	2.20
3	2.02	3	2.83
4	2.35	4	3.35
6	2.92	5	3.80

Freezing-point data for mixtures of cinnamic acid and dimethylpyrone and for hydrocinnamic acid and dimethylpyrone are given by Kendall, 1914.

**BromoCINNAMIC ACIDS.**

**SOLUBILITY OF  $\alpha$  AND OF  $\beta$  BROMOCINNAMIC ACIDS IN WATER AT 25°.**  
(Paul, 1894.)

Acid.	Per 1000 cc. Sat. Solution.	
	Gms.	Millimols.
$\alpha C_6H_5CH:CHBrCOOH$	3.9325	17.32
$\beta C_6H_5CHBr:CHCOOH$	0.5255	2.315

**SOLUBILITY OF  $\alpha$  ISO BROMOCINNAMIC ACID IN AQUEOUS SOLUTIONS OF OXANILIC ACID (Melting point = 120°) AT 25°.**  
(Noyes, 1890.)

Normality of Solutions.		Grams per Liter.	
$C_6H_5NHCO_2COOH$ .	$C_6H_5CH:CHBrCOOH$ .	$C_6H_5NHCO_2COOH$ .	$C_6H_5CH:CHBrCOOH$ .
0	0.0176	0	3.995
0.0275	0.0140	4.54	3.178
0.0524	0.0129	8.65	2.928



Allo **CINNAMIC ACIDS** (Unstable Isomers of Cinnamic Acid).

SOLUBILITY OF EACH OF THE THREE ISOMERIC ALLOCINNAMIC ACIDS AT THE MELTS OF THE THREE ISOMERS IN WATER.

(Meyer, 1911.)

Results for:

Allocinnamic Acid of M. pt. 68°.		Allocinnamic Acid of M. pt. 58°. (Natural Isocinnamic Acid.)		Allocinnamic Acid of M. pt. 42°. (Artificial Isocinnamic Acid.)		Melted Allo- cinnamic Acid	
t°.	Gms. Acid per Liter.	t°.	Gms. Acid per Liter.	t°.	Gms. Acid per Liter.	t°.	Gms. per L.
18	6.88	18	7.62	18	8.95	18	13.
25	8.45	25	9.37	25	11.03	25	14.
35	11.14	35	12.39	35	14.61	35	16.
45	14.46	45	16.09			45	18.
55	18.45					55	20.

These curves intersect that for the melted acid at the melting points of the solid isomers.

The results show that the three isomers are polymorphic modifications of *cis* acid.

100 gms. ligroin (b. pt. 60–70°) dissolve more than 16 gms. isocinnamic acid (Liebermann).

100 gms. ligroin (b. pt. 60–70°) dissolve approx. 2 gms. allocinnamic acid.

SOLUBILITY OF  $\alpha$  CHLOROCINNAMIC ACID, ETC., IN BENZENE.  
(Stoermer and Heymann, 1913.)

Name of Compound.	M. pt.	t°.	Gms. Cmpd. per 100 Gms. C <sub>6</sub> H <sub>6</sub> .	Name of Compound.	M. pt.	t°.	Gms. Cmpd. per 100 Gms. C <sub>6</sub> H <sub>6</sub> .
$\alpha$ Chlor-	137	20	2.6	$\beta$ Brom-	135	13	
Allo $\alpha$ " cin-	111	21	11	Allo $\beta$ " cin-	159.5	14	
$\alpha$ Brom-	131	20	5.17	<i>cis</i> Dichlor-	121	13	
Allo $\alpha$ " Acid	120	18.5	6.9	<i>trans</i> " Acid	101	14	
$\beta$ Chlor-	142	17	1.94	<i>cis</i> Dibrom-	100	14	
Allo $\beta$ " "	132	16	3.17	<i>trans</i> " "	136	14	

FREEZING-POINT DATA (Solubility, see footnote, p. 1) FOR MIXTURES OF CINNAMIC ACID AND OTHER COMPOUNDS, AND OF CINNAMIC ACID DERIVATIVES AND OTHER COMPOUNDS.

Cinnamic Acid + Phenylpropionic Acid (Bruni and Gorni)  
*p* Methoxycinnamic Acid + Hydroquinone (de Koch)  
 $\alpha$  Monochlorcinnamic Aldehyde +  $\alpha$  Monobromcinnamic Aldehyde (Küster)  
 Cinnamylidene + Diphenylbutadiene (Pasca)  
 " + Diphenyldiacetylene

**CITRIC ACID** (CH<sub>2</sub>)<sub>2</sub>COH(COOH)<sub>2</sub>·H<sub>2</sub>O.

SOLUBILITY OF HYDRATED AND OF ANHYDROUS CITRIC ACID, DETERMINED SEPARATELY, IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°.  
(Seidell, 1910.)

Results for Hydrated Citric Acid.			Results for Anhydrous Citric Acid		
Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	d <sub>25</sub> of Sat. Sol.	Gms. (CH <sub>2</sub> ) <sub>2</sub> COH- (COOH) <sub>2</sub> ·H <sub>2</sub> O per 100 Gms. Sat. Solution.	Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	d <sub>25</sub> of Sat. Sol.	Gms. (CH <sub>2</sub> ) <sub>2</sub> COH- (COOH) <sub>2</sub> per 100 Gms. Sat. Solution.
0	1.311	67.5	20	1.297	62.3
20	1.286	66	40	1.246	59
40	1.257	64.3	60	1.190	54.8
50	1.237	63.3	70	1.160	52.4
60	1.216	62	80	1.120	48.5
70	1.192	60.8*	90	1.065	43.7
80	1.163	58.1*	100	1.010	38.5
90	1.125	54.7*			
100	1.068	49.8*			

\* Solid phase dehydrated more or less completely.



### Results for Hydrated Citric Acid.

### Results for Anhydrous Citric Acid.

ns. 95% formic acid dissolve	12.25 gms.	citric acid at 20°.	(Aschan, 1913.)
ns. dichlorethylene dissolve	0.005 gm.	citric acid at 15°.	(Wester & Bruins, '14.)
trichlorethylene	" 0.012 "	" " " "	" "
methyl alcohol	" 197 gms.	" " " "	19°.
propyl alcohol	" 62.8 "	" " " "	(Timofiew, 1914.)

### DISTRIBUTION OF CITRIC ACID BETWEEN WATER AND ETHER. (Pinnow, 1915.)

### Results at 15°.

### Results at 25.5°.

**I AM NOT.**

SOLUBILITY IN WATER AT ORDINARY TEMPERATURE. (Lal De, 1917.)

### DOUBLE SALTS.

### SOLUBILITY IN WATER.

1 - J. pr. Chem. (2) 18, 205, '78; 19, 49, '79; Kurnakoff - J. russ. phys. chem. Ges. 24, 629, 92.)

Name.	Formula.	t°.	Gms. Salt per 100 Gms. H <sub>2</sub> O.
urpureo cobaltic bromide	CoCl(NH <sub>3</sub> ) <sub>5</sub> Br <sub>2</sub>	14.3	0.467
urpureo cobaltic bromide	CoBr(NH <sub>3</sub> ) <sub>5</sub> Br <sub>2</sub>	16	0.19
etra amine cobaltic chloride	CoCl(NH <sub>3</sub> ) <sub>4</sub> (OH <sub>2</sub> )Cl <sub>2</sub>		2.50
urpureo cobaltic chloride	CoCl(NH <sub>3</sub> ) <sub>5</sub> Cl <sub>2</sub>	0	0.232
urpureo cobaltic chloride	CoCl(NH <sub>3</sub> ) <sub>5</sub> Cl <sub>2</sub>	15.5	0.41
urpureo cobaltic chloride	CoCl(NH <sub>3</sub> ) <sub>5</sub> Cl <sub>2</sub>	46.6	1.03
baltic chloride	Co(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>3</sub>	0	4.26
baltic chloride	Co(NH <sub>3</sub> ) <sub>6</sub> Cl <sub>3</sub>	46.6	12.74
baltic chloride	Co(NH <sub>3</sub> ) <sub>5</sub> (OH <sub>2</sub> )Cl <sub>2</sub>	0	16.12
baltic chloride	Co(NH <sub>3</sub> ) <sub>5</sub> (OH <sub>2</sub> )Cl <sub>2</sub>	16.2	24.87
urpureo cobaltic iodide	CoCl(NH <sub>3</sub> ) <sub>5</sub> I <sub>2</sub>	19.2	2.0
urpureo cobaltic nitrate	CoCl(NH <sub>3</sub> ) <sub>5</sub> (NO <sub>3</sub> ) <sub>2</sub>	15	1.25
urpureo cobaltic sulphate	CoCl(NH <sub>3</sub> ) <sub>5</sub> SO <sub>4</sub> .2H <sub>2</sub> O	17.3	0.75
urpureo cobaltic nitrate	Co(NO <sub>3</sub> ) <sub>3</sub> (NH <sub>3</sub> )(NO <sub>3</sub> ) <sub>2</sub>	16	0.36



# COBALT ACETATE

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## COBALT ACETATE $\text{Co}(\text{CH}_3\text{COO})_2$ .

100 cc. anhydrous hydrazine dissolve 1 gm. cobalt acetate with evolution of gas at room temp. (Welsh and Broderick, 1915)

## COBALT BROMIDE $\text{CoBr}_2$ .

### SOLUBILITY IN WATER.

(Etard, 1894.)

Gms.  $\text{CoBr}_2$  per 100 gms. solution  $\begin{matrix} 66.7 \\ 66.8 \\ 68.1 \end{matrix}$   $\begin{matrix} 59^\circ \\ 75^\circ \\ 97^\circ \end{matrix}$  (blue)

100 gms. methyl acetate ( $d_{18} = 0.935$ ) dissolve 10.3 gms.  $\text{CoBr}_2$  at  $18^\circ$ ,  $d_{18}$  of sat. solution = 1.013. (Naumann, 1909)

## COBALT CHLORATE $\text{Co}(\text{ClO}_3)_2$ .

### SOLUBILITY IN WATER.

(Meusser, 1902.)

$t^\circ$ .	Gms. $\text{Co}(\text{ClO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Co}(\text{ClO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	$t^\circ$ .	Gms. $\text{Co}(\text{ClO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Co}(\text{ClO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
-12	29.97	3.41	Ice	18	64.19	14.28	$\text{Co}(\text{ClO}_3)_2 \cdot 4\text{H}_2\text{O}$
-21	53.30	9.08	$\text{Co}(\text{ClO}_3)_2 \cdot 6\text{H}_2\text{O}$	21	64.39	14.51	"
-19	53.61	9.20	"	35	67.09	16.10	"
0	57.45	10.75	"	47	69.66	18.29	"
10.5	61.83	12.90	"	61	76.12	25.39	"

Density of solution saturated at  $18^\circ = 1.861$ .

## COBALT PERCHLORATE $\text{Co}(\text{ClO}_4)_2 \cdot 9\text{H}_2\text{O}$ .

### SOLUBILITY IN WATER.

(Goldblum and Terlikowski, 1912.)

$t^\circ$ .	Gms. $\text{Co}(\text{ClO}_4)_2$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	$t^\circ$ .	Density Sat. Sol.	Gms. $\text{Co}(\text{ClO}_4)_2$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
-10.9	32.67	Ice	0	1.564	100	$\text{Co}(\text{ClO}_4)_2 \cdot 5\text{H}_2\text{O}$
-30.7	58.16	"	7.5	1.566	101.9	"
-62.2 Eutec.	...	Ice + $\text{Co}(\text{ClO}_4)_2 \cdot 9\text{H}_2\text{O}$	18	1.567	103.8	"
-30.7	83.2	$\text{Co}(\text{ClO}_4)_2 \cdot 9\text{H}_2\text{O}$	26	1.581	113.4	"
-21.3	90.6	"	45	1.588	115	"

## COBALT CHLORIDE $\text{CoCl}_2$ .

### SOLUBILITY IN WATER.

(Etard — Compt. rend. 113, 699, '91; Ann. chim. phys. [7] 2, 537, '94.)

$t^\circ$ .	Gms. $\text{CoCl}_2$ per 100 Gms. Solution.	Solid Phase.	$t^\circ$ .	Gms. $\text{CoCl}_2$ per 100 Gms. Solution.	Solid Phase.
-10	27.0	$\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$ (red)	35	38.0	$\text{CoCl}_2 \cdot \text{H}_2\text{O}$ (violet)
0	29.5	"	40	41.0	"
+10	31.5	"	50	47.0	"
20	33.5	"	60	47.5	$\text{CoCl}_2 \cdot \text{H}_2\text{O}$ (blue)
25	34.5	"	80	49.5	"
30	35.5	"	100	51.0	"

### SOLUBILITY OF COBALT AMMONIUM CHLORIDES IN WATER.

(Kurnakoff — J. russ. phys. chem. Ges. 24, 629, '93; J. Chem. Soc. 64, ii, 509, '93.)

Salt.

$\text{CoCl}_2 \cdot 5\text{NH}_3$   
 $\text{CoCl}_2 \cdot 5\text{NH}_3 \cdot \text{H}_2\text{O}$   
 $\text{CoCl}_2 \cdot 6\text{NH}_3$

Grams per 100 Grams  $\text{H}_2\text{O}$  at:

$0^\circ$ .	$10.9^\circ$ .	$40.6^\circ$ .
0.232	...	1.031
16.12	24.87	...
4.26	...	12.74



### SOLUBILITY OF COBALT CHLORIDE IN AQUEOUS HYDROCHLORIC ACID SOLUTIONS AT 0°.

(Engel — Ann. chim. phys. [6] 7, 355, '89.)

Milligram Mols. per 10 cc. Sol.		Sp. Gr. of Solutions.	Gms. per 100 Gms. Solution.		Gms. per 100 cc. Solution.	
CoCl <sub>2</sub> .	HCl.		CoCl <sub>2</sub> .	HCl.	CoCl <sub>2</sub> .	HCl.
62.4	0	1.343	30.17	0.00	40.5	0
58.52	3.7	1.328	28.62	0.102	38.0	0.135
50.8	11.45	1.299	25.39	0.321	33.0	0.417
37.25	25.2	1.248	19.43	0.738	24.2	0.919
12.85	55.0	1.167	7.15	1.718	8.34	2.00
4.75	74.75	1.150	2.68	2.369	3.08	2.72
12.0	104.5	1.229	6.34	3.099	7.79	3.81
25.0	139.0	1.323	12.27	3.829	16.24	5.07

### SOLUBILITY OF COBALT CHLORIDE IN AQUEOUS ALCOHOL

AT 11.5°.

(Böttker — Z. physik. Chem. 22, 509, '97.)

10 gms. of CoCl<sub>2</sub>·6H<sub>2</sub>O were added to 20 cc. of alcohol and in addition the amounts of CoCl<sub>2</sub> shown in the second column. The solutions were shaken 2 hours, 5 cc. withdrawn, and the amount of dissolved CoCl<sub>2</sub> determined by evaporation and weighing.

Vol. % Alcohol.	Gms. CoCl <sub>2</sub> Added.	Gms. per 5 cc. Solution.		Vol. % Alcohol.	Gms. CoCl <sub>2</sub> Added.	Gms. per 5 cc. Sol.	
		H <sub>2</sub> O.	CoCl <sub>2</sub> .			H <sub>2</sub> O.	CoCl <sub>2</sub> .
91.3	0.0	1.325	1.168	99.3	0.612	0.764	1.459
98.3	0.0	1.134	1.214	99.3	0.813	0.688	1.568
98.3	0.0	1.068	1.181	99.3	1.022	0.634	1.713
99.3	0.0	1.045	1.199	99.3	1.240	0.553	1.831
99.3	0.194	0.899	1.204	99.3	1.446	0.483	1.943
99.3	0.400	0.829	1.325	99.3	1.650	0.500	2.183

100 gms. sat. solution in alcohol (0.792 Sp. Gr.) contain 23.66 gms. CoCl<sub>2</sub>. Sp. Gr. = 1.0107.

(Winkler — J. pr. Chem. 91, 207, '64.)

### SOLUBILITY OF COBALT CHLORIDE IN ORGANIC SOLVENTS.

Solvent.	t°.	Gms. per 100 Gms. Solvent.		Authority.
		CoCl <sub>2</sub> .	CoCl <sub>2</sub> ·2H <sub>2</sub> O.	
Acetone	0	9.11	17.16	(von Laszczynski, 1894.)
"	22.5	9.28	17.06	(von Laszczynski, 1894.)
"	25	8.62	...	(Krug and McElroy, 1892.)
"	18	2.75	...	(Naumann, 1904.)
Ethyl Acetate	14	0.08	...	(von Laszczynski, 1894.)
"	79	0.26	...	"
Ether, Abs.	...	0.021	0.291	(Böttker, 1897.)
Glycol	...	10.7 (per 100 g. sol.)		(de Coninck, 1905.)
Acetonitrile	18	4.08	...	(Naumann and Schier, 1914.)
Methyl Acetate	18	0.369*	...	(Naumann, 1909.)
95% Formic Acid	20.5	6.2	...	(Aschan, 1913.)
Anhy. Hydrazine	±15	1	...	(Welsh and Broderson, 1915)

\* d<sub>4</sub> sat. sol. = 0.938.



SOLUBILITY OF COBALT CHLORIDE IN PYRIDINE.  
(Pearce and Moore, 1915.)

t°.	Gm. CoCl <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gm. CoCl <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gm. CoCl <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-48.2	0	C <sub>5</sub> H <sub>5</sub> N	34.6	0.749	1.4	74.8	2.037	1.3
-50.3 Eutec.	...	" + 1.6	37.6	0.754	"	78.2	2.276	"
-45	0.4185	1.6	44.6	0.950	"	79.8	2.428	"
-30	0.4205	"	47.2	1.020	"	88	3.284	"
-19.6	0.4208	"	51	1.110	"	90 tr. pt.	...	" + CoCl <sub>2</sub>
-10	0.4310	"	55	1.192	"	96.5	7.251	CoCl <sub>2</sub>
0	0.4307	"	60	1.324	"	98.8	7.936	"
15 tr. pt.	...	1.6 + 1.4	64.2	1.460	"	106	12.540	"
23	0.569	1.4	68	1.572	"	110	14.165	"
25	0.575	"	70 tr. pt.	...	" + 1.2			

1.6 = CoCl<sub>2</sub>·6C<sub>5</sub>H<sub>5</sub>N.    1.4 = CoCl<sub>2</sub>·4C<sub>5</sub>H<sub>5</sub>N.    1.2 = CoCl<sub>2</sub>·2C<sub>5</sub>H<sub>5</sub>N.

## COBALT CITRATES.

SOLUBILITY IN WATER.  
(Pickering, 1915.)

Salt.	Formula.	t°.	Gms. per 100 cc. Sat. Sol.	Salt
Cobalt Citrate (normal)	Co <sub>3</sub> [(COO.CH <sub>3</sub> ) <sub>2</sub> C(OH)COO] <sub>2</sub> ·2H <sub>2</sub> O	10	0.08	0.267
Cobalt Hydrogen Citrate	CoH[(COO.CH <sub>3</sub> ) <sub>2</sub> C(OH)COO]	10	0.20	0.906
Cobalt Potassium Citrate	KCo[(COO.CH <sub>3</sub> ) <sub>2</sub> C(OH)COO]·4H <sub>2</sub> O	10	1.05	5.11
Cobalt Potassium Citrate	K <sub>2</sub> Co[(COO.CH <sub>3</sub> ) <sub>2</sub> C(OH)COO] <sub>2</sub>	10	3.04	31

COBALT FLUORIDE CoF<sub>2</sub>·4H<sub>2</sub>O.

100 gms. sat. solution in water contain 2.23 gms. of cobalt fluoride of  $\alpha$  variety.

100 gms. sat. solution in water contain 2.32 gms. of cobalt fluoride of  $\beta$  variety.  
(Costachescu, 1920)

COBALT IODATE Co(IO<sub>3</sub>)<sub>2</sub>.

SOLUBILITY IN WATER.  
(Meusser — Ber. 34, 2435, '01.)

t°.	Solid Phase : Co(IO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O.		Co(IO <sub>3</sub> ) <sub>2</sub> ·2H <sub>2</sub> O.		Co(IO <sub>3</sub> ) <sub>2</sub> .	
	G.	M.	G.	M.	G.	M.
0	0.54	0.028	0.32	0.014	...	...
18	0.83	0.038	0.45	0.020	1.03	0.046
30	1.03	0.046	0.52	0.023	0.89	0.040
50	1.46	0.065	0.67	0.030	0.85	0.030
60	1.86	0.084	...	...	...	...
65	2.17	0.098	...	...	...	...
75	...	...	0.84	0.038	0.75	0.033
100	...	...	1.02	0.045	0.69	0.031

G = Gms. Co(IO<sub>3</sub>)<sub>2</sub> per 100 gms. solution.    M = Mols. Co(IO<sub>3</sub>)<sub>2</sub> per 100 Mols. H<sub>2</sub>O.

COBALT IODIDE CoI<sub>2</sub>.

SOLUBILITY IN WATER.

(Etard — Compt. rend. 113, 699, '91; Ann. chim. phys. [7] 2, 537, '94)

The accuracy of these results is doubtful.

t°.	Gms. CoI <sub>2</sub> per 100 Gms. Solution.	Solid Phase.	t°.	Gms. CoI <sub>2</sub> per 100 Gms. Solution.	Solid Phase.
-10	55.5	CoI <sub>2</sub> ·H <sub>2</sub> O (green)	25	67.5	CoI <sub>2</sub> ·H <sub>2</sub> O (olive)
0	58.0	"	30	70.0	"
10	61.5	"	40	75.0	CoI <sub>2</sub> ·H <sub>2</sub> O (yellow)
15	63.2	"	50	79.0	"
20	65.2	"	80	80.0	"
25	67	"	110	81.0	"



**COBALT MALATE**  $\text{Co}(\text{COO} \cdot \text{CH}_2 \cdot \text{CHOHCOO})_2 \cdot 2\text{H}_2\text{O}$ .

100 cc. sat. solution in water contain 0.14 gm. Co = 0.453 gm. anhydrous salt at 10°. (Pickering, 1915.)

**COBALT MALONATES.**

SOLUBILITY OF COBALT MALONATES IN WATER.  
(Lord, 1907.)

Salt.	Formula.	t°.	Gms. Anhydrous Salt per 100 Gms. Sat. Sol.
Cobalt Malonate	$\text{CoCH}_3(\text{COO})_2 \cdot 2\text{H}_2\text{O}$	18	1.353
Ammonium Malonate	$\text{Co}(\text{NH}_4)_2[\text{CH}_3(\text{COO})_2]_2 \cdot 4\text{H}_2\text{O}$	18	10.61
Caesium "	$\text{CoCs}_2[\text{CH}_3(\text{COO})_2]_2 \cdot 4\text{H}_2\text{O}$	18	14.23
Potassium "	$\text{CoK}_2[\text{CH}_3(\text{COO})_2]_2 \cdot 4\text{H}_2\text{O}$	18	4.26

**COBALT NITRATE**  $\text{Co}(\text{NO}_3)_2$ .

## SOLUBILITY IN WATER.

(Funk — Wiss. Abh. p. t. Reichsanstalt 3, 439, '00.)

t°.	Gms. $\text{Co}(\text{NO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Co}(\text{NO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Co}(\text{NO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Co}(\text{NO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase
-26	39.45	6.40	$\text{Co}(\text{NO}_3)_2 \cdot 9\text{H}_2\text{O}$	41	55.96	12.5	$\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
-20.5	42.77	7.35	"	56	62.88	16.7	"
-21	41.55	6.98	$\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	55	61.74	15.8	$\text{Co}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$
-10	43.69	7.64	"	62	62.88	16.7	"
-4	44.85	7.99	"	70	64.89	18.2	"
0	45.66	8.26	"	84	68.84	21.7	"
+18	49.73	9.71	"	91	77.21	33.3	"

Density of solution saturated at 18° = 1.575.

## SOLUBILITY OF COBALT NITRATE IN GLYCOL.

(de Coninck, 1905.)

100 grams saturated solution contain 80 gms. cobalt nitrate.

**COBALT RUBIDIUM NITRITE**  $\text{Rb}_2\text{Co}(\text{NO}_2)_4 \cdot \text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 0.005 gm. of the salt.

(Rosenblatt, 1886.)

**COBALT OXALATE**  $\text{Co}(\text{COO})_2$ .

100 gms. 95% formic acid dissolve 0.04 gm.  $\text{Co}(\text{COO})_2$  at 19.8°. (Aschan, 1913.)

**COBALT SULFATE**  $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Mukder; Tobler, 1855; Koppel, Wetzel, 1905.)

t°.	Gms. $\text{CoSO}_4$ per 100 Gms.		Mols. $\text{CoSO}_4$ per 100 Mols. $\text{H}_2\text{O}$	t°.	Gms. $\text{CoSO}_4$ per 100 Gms.		Mols. $\text{CoSO}_4$ per 100 Mols. $\text{H}_2\text{O}$
	Solution.	Water.			Solution.	Water.	
0	20.35	25.55	2.958	35	31.40	45.80	5.31
5	21.90	28.03	3.251	40	32.81	48.85	5.664
10	23.40	30.55	3.540	50	35.56	55.2	...
15	24.83	33.05	3.831	60	37.65	60.4	...
20	26.58	36.21	4.199	70	39.66	65.7	...
25	28.24	39.37	4.560	80	41.18	70	...
30	29.70	42.26	4.903	100	45.35	83	...

100 gms.  $\text{H}_2\text{O}$  dissolve 37.8 gms.  $\text{CoSO}_4$  at 25°.

(Wagner, 1910.)

Freezing-point data (solubility, see footnote, p. 1) for mixtures of  $\text{CoSO}_4$  +  $\text{Li}_2\text{SO}_4$ ,  $\text{CoSO}_4$  +  $\text{K}_2\text{SO}_4$  and  $\text{CoSO}_4$  +  $\text{Na}_2\text{SO}_4$  are given by Calcagni and Marotta (1913).



**SOLUBILITY OF MIXTURES OF  $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$  AND  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$   
IN WATER.**

(Koppel; Wetzel.)

t°.	Gms. per 100 Gms. Solution.		Gms. per 100 Gms. $\text{H}_2\text{O}$ .		Mols. per 100 Mols. $\text{H}_2\text{O}$ .		Solid Phase.
	$\text{CoSO}_4$ .	$\text{Na}_2\text{SO}_4$ .	$\text{CoSO}_4$ .	$\text{Na}_2\text{SO}_4$ .	$\text{CoSO}_4$ .	$\text{Na}_2\text{SO}_4$ .	
0	16.56	7.63	21.85	10.07	2.54	1.27	$\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$ + $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
5	17.46	9.59	23.94	13.15	2.77	1.67	"
10	17.90	11.73	25.41	16.67	2.94	2.11	"
20	17.59	16.43	26.65	24.91	3.09	3.15	$\text{CoNa}_2(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$
25	17.06	15.70	25.36	23.32	2.95	2.97	"
30	15.94	14.93	23.15	21.61	2.70	2.74	"
35	15.73	14.52	22.54	20.85	2.62	2.64	"
40	14.87	14.22	20.98	20.05	2.46	2.53	"
18.5	18.75	15.61	28.61	23.82	3.32	3.02	$\text{CoNa}_2(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$ + $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$
20	19.30	15.10	29.42	23.01	3.41	2.92	"
25	20.30	13.60	30.74	20.58	3.56	2.61	"
30	21.67	12.05	32.70	18.17	3.79	2.30	"
35	22.76	10.43	34.06	15.61	3.95	1.98	"
40	24.05	9.16	35.01	13.72	4.81	1.74	"
18.5	16.87	16.97	25.50	25.65	2.96	3.25	$\text{CoNa}_2(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$ + $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
20	15.41	18.12	23.18	27.26	2.69	3.45	"
25	10.63	23.26	16.07	35.17	1.86	4.46	"
30	6.01	28.67	9.20	43.74	1.07	5.54	"
35	4.56	32.14	7.19	50.79	0.835	6.44	$\text{CoNa}_2(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$ + $\text{Na}_2\text{SO}_4$
40	4.72	31.78	7.45	50.10	0.864	6.34	"

**SOLUBILITY OF COBALT SULPHATE IN METHYL AND ETHYL ALCOHOL  
AND IN GLYCOL.**

Solvent.	t°.	Gms. per 100 Gms. Solvent.		Observer.
		$\text{CoSO}_4$ .	$\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$ .	
Methyl Alcohol (abs.)	3	...	42.8	(de Bruyn—Z. physik. Ch. 10, 764, '92.)
"	15	...	50.9	"
"	18	1.04	54.5	"
" (93.5%)	3	...	13.3	"
" (50%)	3	...	1.8	"
Ethyl Alcohol (abs.)	3	...	2.5	"
Glycol	..	(per 100 gms. solution) 3.1		(de Coninck—Bull. acad. roy. Belgique, 359, '05.)

**COBALT SULFIDE  $\text{CoS}$ .**

One liter water dissolves 0.00379 gm.  $\text{CoS}$  at 18° (electrolytic conductivity method, assuming complete dissociation and hydrolysis). (Weigel, 1906.)



**COCAINE**  $C_{17}H_{21}NO_3$ .

## SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. $C_{17}H_{21}NO_3$ per 100 Gms. Solvent.	Authority.
Water	20	0.028	(Zalai, 1910.)
"	±20	0.140	(Baroni and Barlinetti, 1911.)
"	25	0.17	(U. S. P.)
"	80	0.38	"
3 Gms. $H_3BO_3$ in Aq. 50% Glycerol	±20	8	(Baroni and Barlinetti, 1911.)
Alcohol (92.5 Wt. %)	25	20	(U. S. P.)
Ether	25	26.3	"
"	18-22	11.6	(Müller, 1903.)
Ether sat. with $H_2O$	18-22	34	"
Water sat. with Ether	18-22	0.254	"
Aniline	20	76	(Scholtz, 1912.)
Carbon Tetrachloride	20	31.94	(Gori, 1913.)
Chloroform	18-22	100+	(Müller, 1903.)
Benzene	18-22	100	"
Ethyl Acetate	18-22	59	"
Petroleum Ether	18-22	2.37	"
Pyridine	20-25	80+	(Dehn, 1917; Scholtz, 1912.)
Piperidine	20	56	(Scholtz, 1912.)
Diethylamine	20	36	"
Sesame Oil	20	4.34*	(Zalai, 1910.)
Olive Oil	25	8.3	(U. S. P.)
Oil of Turpentine	25	7.1	"

\* Per 100 cc.

**COCAINE HYDROCHLORIDE**  $C_{17}H_{21}NO_4 \cdot HCl$ .100 gms.  $H_2O$  dissolve 250 gms. of the salt at 25° and 1000 gms. at 80°. (U. S. P.)

100 gms. 92.3% alcohol dissolve 38 gms. salt at 25° and 71 gms. at 60°. (U. S. P.)

100 gms. chloroform dissolve 5.4 gms. salt at 25°. (U. S. P.)

100 gms. glycerol dissolve 25 gms. salt at 15°. (B. P.)

**COCAINE PERCHLORATE**  $C_{17}H_{21}NO_4 \cdot HClO_4$ .100 gms.  $H_2O$  (containing 8% free  $HClO_4$ ) dissolve 0.26 gm. perchlorate at 6°. (Hofmann, Roth, Höbold and Metzler, 1910.)**CODEINE**  $C_{18}H_{21}NO_3 \cdot H_2O$ .**CODEINE PHOSPHATE**  $C_{18}H_{21}NO_3 \cdot H_3PO_4 \cdot 2H_2O$ .**CODEINE SULFATE**  $(C_{18}H_{21}NO_3)_2 \cdot H_2SO_4 \cdot 5H_2O$ .

## SOLUBILITY OF EACH SEPARATELY IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. per 100 Gms. Solvent.			Authority.
		Codeine.	C. Phos- phate.	C. Sulfate.	
Water	25	0.80-1.7	44.9	3.3	(U. S. P.; Baroni and Barlinetto, [1911.]
"	20	0.84	...	...	(Zalai 1910.)
"	80	1.70	227	16	(U. S. P.)
Alcohol (92.3 Wt. %)	25	63.7	0.383	0.1	(Schaeffer, 1913; U. S. P.)
"	60	108.7	1.03	0.27	(U. S. P.)
Methyl Alcohol	25	62.8	...	0.56	(Schaeffer, 1913.)
Chloroform	25	133-151	0.015	0.007	(Schaeffer, U. S. P.)
Carbon Tetrachloride	20	2.94-1.33	...	...	(Gori, 1913; Beilstein, Suppl.)
Ether	25	8	0.075	...	(U. S. P.)
Benzene	25	11.4	...	Insol.	(Schaeffer, 1913.)
Trichlorethylene	15	12	...	...	(Wester and Bruins, 1914.)
3 Gms. $H_3BO_3$ per 100 cc. aq. 50% Glycerol	ord. t.	4	...	...	(Baroni and Barlinetto, 1911.)

100 gms. trichlorethylene dissolve 0.014 gm. codeine hydrochloride at 15°.

(Wester and Bruins, 1914.)

Data for the solubility of codeine and codeine sulfate in mixtures of alcohols, benzene and chloroform are given by Schaeffer (1913).



# **COLCHICINE**

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## **COLCHICINE** $C_{22}H_{25}NO_6$ .

### **SOLUBILITY IN SEVERAL SOLVENTS.**

(Müller, 1903; U. S. P.)

Solvent.	t°.	Gms. $C_{22}H_{25}NO_6$ per 100 Gms. Solvent.	Solvent.	t°.	(
Water	18-22	9.6	Water sat. with Ether	18-22	
"	25	4.5	Benzene	18-22	
"	80	5	Benzene	25	
"	82	13.7*	Chloroform	18-22	
Ether	18-22	0.13	Carbon Tetrachloride	18-22	
"	25	0.64	Ethyl Acetate	18-22	
" sat. with H <sub>2</sub> O	18-22	0.18	Petroleum Ether	18-22	

\* Beilstein.

## **COLCHICINE SALTS.**

Name.	Formula.	Solvent.	t°.	Gms. Salt per Liter Sat. Sol.	A
Colchicine Iodohydrate	$C_{22}H_{25}NO_6 \cdot HI$	Water	30	0.84	(P)
Iso Colchicine Iodohydrate	"	"	30	3.86	
Colchicine Silicotungstate	$\{ (C_{22}H_{25}NO_6)_3 SiO_2 \}$ $\{ 12WO_3 \cdot 2H_2O \}$	"	15	0.083	G
		Aq. 1% HCl	15	0.007	

## **COLLIDINE** (2.4.6 Trimethyl Pyridine) $C_8H_9N(CH_3)_3$ .

### **SOLUBILITY IN WATER.**

(Rothmund, 1898.)

t°.	Gms. Collidine per 100 Gms.		t°.	Gms. Collidine per	
	Aq. Layer.	Collidine Layer.		Aq. Layer.	Collidi
5.7 crit. t.		17.20			
10	7.82	41.66	80	1.73	84
20	3.42	54.92	100	1.78	84
30	2.51	62.80	120	1.82	84
40	1.93	70.03	140	2.19	84
60	1.76	80.19	160	2.93	84
			180	3.67	

## **COLLIDINE** (1.3.5 Trimethyl Pyridine) $C_8H_9N(CH_3)_3$ .

### **DISTRIBUTION BETWEEN WATER AND TOLUENE.**

(Hantzsch and Vagt, 1901.)

t°.	G. Mols. Collidine per Liter.		Dist. Coef.	t°.	G. Mols. Collidine per Liter.	
	H <sub>2</sub> O Layer.	Toluene Layer.			H <sub>2</sub> O Layer	Toluene Layer.
0	0.0035	0.0580	0.0603	50	0.0017	0.0596
10	0.0026	0.0587	0.0443	70	0.0015	0.0597
20	0.0022	0.0588	0.0374	90	0.0013	0.0598
30	0.0020	0.0594	0.0337			

## **CONGO RED** $[C_6H_4 \cdot N : N \cdot C_{10}H_8(NH_2)SO_3Na]_2$ .

100 gms. H<sub>2</sub>O dissolve 11.6 gms. congo red at 20°-25°.

100 gms. pyridine dissolve 0.29 gm. congo red at 20°-25°.

100 gms. aq. 50% pyridine dissolve 7.32 gms. congo red at 20-25°.

## **CONIINE** ( $\alpha$ Propyl Piperidine) $C_8H_{17}N$ .

100 gms. H<sub>2</sub>O dissolve 1.83 gms. coniine at 20°.

## **COPPER ACETATE** $Cu(C_2H_3O_2)_2 \cdot H_2O$ .

100 gms. glycerol ( $d_{15} = 1.256 = 96\%$ ) dissolve 10 gms. copper at 15°-16°.

(Ossend



**SOLUBILITY OF ANHYDROUS COPPER ACETATE IN PYRIDINE.**  
(Mathews and Bengler, 1914.)

t°.	Gms. $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2$ per 100 Gms. Sat. Sol.	Solid Phase.
-11.6	0.37	$\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_{1-4} \cdot \text{C}_5\text{H}_5\text{N}$	45.2	4.17	$\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_{1-4} \cdot \text{C}_5\text{H}_5\text{N}$
+2	0.6	"	34.8	3.75	$\text{Cu}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot \text{C}_5\text{H}_5\text{N}$
13	1.03	"	55.7	4.13	"
26.45	1.61	"	64.3	4.48	"
37.4	2.83	"	76.2	4.83	"
41.9	3.12	"	83.3	5.40	"
43.2	3.39	"	95.4	6.31	"

Transition point = 44.7°.

**COPPER BROMIDE (ous)  $\text{Cu}_2\text{Br}_2$ .**

**SOLUBILITY OF CUPROUS BROMIDE IN AQUEOUS SOLUTIONS OF POTASSIUM BROMIDE AT 18°-20°.**  
(Bodländer and Storbeck, 1902.)

Millimols per Liter.					Grams per Liter.			
r.	Total Cu.	Total Br.	Cu (ic).	Cu (ous).	KBr.	Total Cu.	Cu (ic).	Cu (ous).
0	0.3157	0.4320	0.2096	0.1061	0	0.0201	0.0133	0.0067
5	0.119	...	0.012	0.107	2.98	0.0076	0.0007	0.0068
0	0.200	...	0.013	0.187	4.76	0.0127	0.0007	0.0119
0	0.310	...	0.025	0.285	7.15	0.0197	0.0015	0.0181
0	0.423	...	0.012	0.411	9.53	0.0266	0.0007	0.0261
0	0.584	...	...	0.584	11.91	0.0371	...	0.0371
0	0.693	...	...	0.693	14.29	0.0441	...	0.0441
0	8.719	...	...	8.719	59.55	0.5540	...	0.5540

100 gms. acetonitrile dissolve 3.86 gms.  $\text{Cu}_2\text{Br}_2$  at 18°. (Naumann and Schier, 1914.)

Freezing-point lowering data for mixture of  $\text{CuBr} + \text{KBr}$  are given by de launay, 1911.

**COPPER BROMIDE (ic)  $\text{CuBr}_2$ .**

100 gms. acetonitrile dissolve 24.43 gms.  $\text{CuBr}_2$  at 18°. (Naumann and Schier, 1914.)

100 gms. 95% formic acid dissolve 0.16 gm.  $\text{CuBr}_2$  at 21°. (Aschan, 1913.)

**COPPER CARBONATE Basic.**

**SOLUBILITY IN AQUEOUS  $\text{CO}_2$  SOLUTIONS AT 30°.**

(Free, 1908.)

Aq. 0.5%  $\text{Na}_2\text{CO}_3$  and 0.5%  $\text{CuSO}_4$  were mixed and the precipitate washed and suspended in  $\text{H}_2\text{O}$  containing  $\text{CO}_2$  at a pressure slightly above atmospheric, for days. The filtered precipitate was kept in water ready for use. In the fresh solution or dried, the molecular ratio of the constituents was found to be  $1\text{CuO} : 1.15\text{CO}_2 : 0.61\text{H}_2\text{O}$ . For the solubility determinations, about 2 gms. of the precipitate were suspended in 600 cc. of  $\text{H}_2\text{O}$  and  $\text{CO}_2$  passed in to the desired concentration. The mixture was shaken frequently for 3 days. The total  $\text{CO}_2$  the sat. solution was determined and the free  $\text{CO}_2$  calc. by difference, assuming the amount combined to the Cu was in the molecular ratio  $2\text{CuO} : 1\text{CO}_2$ .

Parts per Million.		Parts per Million.	
Free $\text{CO}_2$ .	Metallic Cu.	Free $\text{CO}_2$ .	Metallic Cu.
0 = pure $\text{H}_2\text{O}$	1.5	859	28
157	8.3	961	31
277	13.7	1158	33.7
348	17	1224	34.8
743	25.7	1268-1549	35.3-39.7*

\* Saturated with  $\text{CO}_2$  at 1 + atmosphere.

Results practically identical with the above were obtained for a  $\text{NaCl}$  solution containing 100 parts per million. Data for other concentrations of  $\text{NaCl}$  for other salts are also given. Salts with a common ion depress the solubility.

Those with no common ion increase it slightly. A recalculation of the data of Free is given by Seyler (1908).



SOLUBILITY OF MIXTURES OF COPPER CARBONATE AND POTASSIUM  
CARBONATE IN WATER AT 25°.

(Wood and Jones, 1907-08.)

100 gms. H<sub>2</sub>O dissolve 3.15 gms. CuCO<sub>3</sub> + 105 gms. K<sub>2</sub>CO<sub>3</sub> at 25° when the solid phase in contact with the solution is CuCO<sub>3</sub>.K<sub>2</sub>CO<sub>3</sub> + K<sub>2</sub>CO<sub>3</sub>.

Additional points on the curves were determined but the analytical data are not given. The following approximate values were read from the curve for the double salt, CuCO<sub>3</sub>.K<sub>2</sub>CO<sub>3</sub>:

Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.
K <sub>2</sub> CO <sub>3</sub>	CuCO <sub>3</sub>	
105	3.15	K <sub>2</sub> CO <sub>3</sub> + CuCO <sub>3</sub> .K <sub>2</sub> CO <sub>3</sub>
100	3.20	CuCO <sub>3</sub> .K <sub>2</sub> CO <sub>3</sub>
90	3.40	"
85	3.60	"

The triple point for double salt + CuCO<sub>3</sub> could not be determined since CuCO<sub>3</sub> is not capable of existing alone and decomposes into CO<sub>2</sub> + Cu(OH)<sub>2</sub>.

**COPPER CHLORATE** (ic) Cu(ClO<sub>3</sub>)<sub>2</sub>·4H<sub>2</sub>O.

SOLUBILITY IN WATER.

(Meusser, 1902.)

t°.	Gms. Cu(ClO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Solutions.	Mols. Cu(ClO <sub>3</sub> ) <sub>2</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.	t°.	Gms. Cu(ClO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Solutions.	Mols. Cu(ClO <sub>3</sub> ) <sub>2</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.
-12	30.53	3.43	Ice	18	62.17	12.84	Cu(ClO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O
-31	54.59	9.39	Cu(ClO <sub>3</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	45	66.17	15.28	"
-21	57.12	10.41	"	59.6	69.42	17.73	"
+ 0.8	58.51	11.02	"	71	76.9	25.57	"

Density of solution saturated at 18° = 1.695.

**COPPER CHLORIDE** (ic) CuCl<sub>2</sub>·2H<sub>2</sub>O.

SOLUBILITY IN WATER.

(Reicher and Deventer, 1890; see also Etard, 1894.)

t°.	Gms. CuCl <sub>2</sub> per 100 Gms. Solution.	t°.	Gms. CuCl <sub>2</sub> per 100 Gms. Solution.	t°.	Gms. CuCl <sub>2</sub> per 100 Gms. Solution.
-40 Eutec.	36.3	20	43.5	50	46.65
0	41.4	25	44	60	47.7
10	42.45	30	44.55	80	49.8
17	43.06	40	45.6	100	51.9

Density of solution saturated at 0° = 1.511, at 17.5° = 1.579.

100 gms. sat. solution in water contain 43.95 gms. CuCl<sub>2</sub> at 30°, solid phase, CuCl<sub>2</sub>·2H<sub>2</sub>O. (Schreinemaker, 1910.)

**COPPER CHLORIDE** (ous) CuCl.

100 gms. H<sub>2</sub>O dissolve 1.52 gms. CuCl at 25°.

(Noss, 1912.)

SOLUBILITY OF CUPROUS CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC  
ACID CONTAINING CuCl<sub>2</sub> AT 25°.

(Poma, 1909, 1910.)

Results for 1 N HCl.			Results for 2 N HCl.			Results for 4 N HCl.		
Mols. per Liter.		Solid Phase.	Mols. per Liter.		Solid Phase.	Mols. per Liter.		Solid Phase.
CuCl <sub>2</sub> Added.	CuCl <sub>2</sub> + CuCl.		CuCl <sub>2</sub> Added.	CuCl <sub>2</sub> + CuCl.		CuCl <sub>2</sub> Added.	CuCl <sub>2</sub> + CuCl.	
0	0.0862	CuCl	0	0.2365	CuCl	0	0.7704	CuCl
0.1	0.2017	"	0.094	0.3528	"	0.095	0.9044	"
0.2	0.3256	"	0.188	0.4766	"	0.189	1.0370	"
0.4	0.5707	"	0.235	0.5385	"	0.379	1.3040	"
0.5	0.6924	"	0.282	0.6038	"	0.473	1.4380	"



# SOLUBILITY OF CUPROUS CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID.

(Engel — *Ibid.* [6] 17, 372, '89; Compt. rend. 121, 529, '95.)

Gms. per 10 cc. Sol.		Sp. Gr. of Solutions.	Gms. per 100 cc. Sol.		Gms. per 100 Gms. Sol.	
$\frac{1}{2}\text{Cu}_2\text{Cl}_2$	HCl.		$\text{Cu}_2\text{Cl}_2$	HCl.	$\text{Cu}_2\text{Cl}_2$	HCl.
Results at 0°.						
0.475	8.975	1.05	0.471	0.327	0.448	0.312
1.5	17.5	1.049	1.486	0.638	1.418	0.608
2.9	26.0	1.065	2.872	0.948	2.697	0.932
4.5	34.5	1.080	4.457	1.257	4.127	1.164
8.25	47.8	1.135	8.172	1.743	7.199	1.535
15.5	68.5	1.261	15.7	2.497	12.46	1.980
33.0	104.0	1.345	32.68	3.827	24.30	2.845
Results at 15°-16°.						
7.4	54.4	1.19	7.33	1.983	6.159	1.666
10.8	68.9	1.27	10.69	2.511	8.422	1.977
12.8	75.0	1.29	12.68	2.734	9.826	2.119
16.0	92.0	1.38	15.84	3.346	11.48	2.424

# SOLUBILITY OF CUPRIC CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 0°.

(Engel — *Ann. chim. phys.* [6] 17, 351, '89.)

Gms. per 100 cc. Sol.		Sp. Gr. of Solutions.	Gms. per 100 cc. Sol.		Gms. per 100 Gms. Sol.	
$\frac{1}{2}\text{CuCl}_2$	HCl.		$\text{CuCl}_2$	HCl.	$\text{CuCl}_2$	HCl.
91.75	0	1.49	61.70	0.0	41.41	0.0
86.8	4.5	1.475	58.37	1.64	39.58	1.11
83.2	7.8	1.458	55.95	2.84	38.37	1.95
79.35	10.5	1.435	53.37	3.83	37.19	2.67
68.4	20.25	1.389	46.01	7.38	33.11	5.31
50.0	37.5	1.319	33.62	13.67	25.50	10.37
22.8	70.25	1.231	15.33	25.61	12.46	20.80
23.5	102.5	1.288	15.81	37.36	12.27	29.00
26.7	128.0	1.323	17.96	46.66	13.57	35.26
			29.0	Sat. HCl		

# COPPER CHLORIDE, AMMONIUM CHLORIDE MIXTURES IN AQUEOUS SOLUTION AT 30°.

(Moerburg — *Z. anorg. Chem.* 45, 3, '05.)

Grams per 100 Gms. Sat. Solution.		Grams per 100 Gms. Solid Phase.		Solid Phase.
$\text{CuCl}_2$	$\text{NH}_4\text{Cl}$	$\text{CuCl}_2$	$\text{NH}_4\text{Cl}$	
0	29.5	...	...	$\text{NH}_4\text{Cl}$
1.9	28.6	6.0	48.2	$\text{NH}_4\text{Cl} + \text{CuCl}_2 \cdot \text{NH}_4\text{Cl} \cdot \text{H}_2\text{O}$
3.6	25.9	37.0	34.9	$\text{CuCl}_2 \cdot \text{NH}_4\text{Cl} \cdot \text{H}_2\text{O}$
10.5	16.5	21.7	23.1	"
19.9	9.4	28.5	18.4	"
29.4	4.9	35.1	15.3	"
41.4	2.1	43.1	13.3	"
43.2	2.0	51.9	6.6	$\text{CuCl}_2 \cdot \text{NH}_4\text{Cl} \cdot \text{H}_2\text{O} + \text{CuCl}_2 \cdot \text{H}_2\text{O}$
43.9	0	...	...	$\text{CuCl}_2 \cdot \text{H}_2\text{O}$

Additional determinations for the ammonia end of this system at 25° are given by Foote, 1912.



## COPPER CHLORIDE

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COPPER AMMONIUM CHLORIDE  $\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Meerburg, 1905.)

t°.	Gms. $\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl}$ per 100 Gms. Solution.		Solid Phase.	t°.	Gms. $\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl}$ per 100 Gms. Solution.		Solid Phase.
-10.5	3.87		Ice	30	27.70		$\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O}$
-10.8	20.12			40	30.47		"
-11	20.3		Ice + $\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O}$	50	33.24		"
-10	20.46		$\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O}$	60	36.13		"
0	22.02		"	70	39.35		"
12	24.26		"	80	43.36		"
20	25.95		"				

## SOLUBILITY OF CUPROUS CHLORIDE IN AQUEOUS SOLUTIONS OF CUPRIC SULFATE AT ABOUT 20°.

(Bodländer and Storbeck, 1902.)

Millimols per Liter.					Grams per Liter.				
$\text{CuSO}_4$ .	Total Cu.	Total Cl.	Cu (ic).	Cu (ous).	$\text{CuSO}_4$ .	Total Cu.	Total Cl.	Cu (ic).	Cu (ous).
0	2.880	5.312	2.258	0.622	0	0.183	0.188	0.143	0.040
0.987	3.602	4.908	3.145	0.457	0.158	0.229	0.174	0.200	0.029
1.975	4.553	4.687	4.131	0.422	0.315	0.290	0.166	0.263	0.027
2.962	5.193	4.256	4.625	0.509	0.473	0.330	0.151	0.292	0.032
4.937	7.276	4.329	6.546	0.730	0.788	0.463	0.154	0.416	0.046

## SOLUBILITY OF CUPROUS CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE AT ABOUT 20°.

(Bodländer and Storbeck, 1902.)

Millimols per Liter.					Grams per Liter.				
KCl.	Total Cu.	Total Cl.	Cu (ic).	Cu (ous).	KCl.	Total Cu.	Total Cl.	Cu (ic).	Cu (ous).
0	2.851	5.416	2.222	0.629	0	0.181	0.193	0.141	0.040
2.5	1.955	6.015	1.421	0.534	0.186	0.124	0.213	0.090	0.034
5	1.522	7.525	1.008	0.514	0.373	0.097	0.267	0.069	0.033
10	1.236	11.735	0.475	0.761	0.746	0.079	0.416	0.030	0.048
20	1.446	21.356	0.324	1.122	1.492	0.092	0.759	0.021	0.071
50	2.411	not det.	0.1088	2.302	3.730	0.153	not det.	0.007	0.146
100	4.702	"	0	4.702	7.460	0.299	"	0	0.299
200	9.485	"	0	9.485	14.920	0.603	"	0	0.603
1000	97	"	0	97	74.60	6.170	"	0	6.170
2000	384	"	0	384	149.2	24.42	"	0	24.420

The results in the 3d, 7th, 8th and last line of this table are at 16°.

## SOLUBILITY OF COPPER CHLORIDE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE.

(Hunt, 1870.)

t°.	Gms. $\text{CuCl}_2$ per 100 cc. Solution of:		
	Sat. NaCl.	15% NaCl.	5% NaCl.
11	8.9	3.6	...
40	11.9	6	1.1
90	16.9	10.3	2.6



**SOLUBILITY OF CUPROUS CHLORIDE IN AQUEOUS SOLUTIONS OF FERROUS CHLORIDE AT 21.5° AND VICE VERSA.**

(Kremann and Noss, 1912.)

In order to ascertain the composition of the solid phase, the experiment was made by mixing together weighed amounts of  $H_2O$ ,  $CuCl$  and  $FeCl_2$  and agitating in a thermostat at constant temperature. A weighed portion of the clear saturated solution in each case was analyzed and the composition of the solid phase calculated by difference.

Gms. per 100 Gms. $H_2O$ .		Solid Phase.	Gms. per 100 Gms. $H_2O$ .		Solid Phase.
$FeCl_2$	$CuCl$		$FeCl_2$	$CuCl$	
0	1.53	$CuCl$	43.75	12.42	$CuCl$
6.02	1.33	"	54	17.04	"
11.62	1.80	"	66.40	21.6	"
16.30	3.11	"	73.20	23.20	" + $FeCl_2 \cdot 4H_2O$
26.30	7.12	"	71.90	21.65	$FeCl_2 \cdot 4H_2O$
29.35	8.06	"	69.30	11.9	"
33.12	9.56	"	65.10	0	"

**SOLUBILITY OF CUPROUS CHLORIDE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE AT 26.5° AND VICE VERSA.**

(Kremann and Noss, 1912.)

(See remarks above.)

Gms. per 100 Gms. $H_2O$ .		Solid Phase.	Gms. per 100 Gms. $H_2O$ .		Solid Phase.
$NaCl$	$CuCl$		$NaCl$	$CuCl$	
0	1.55	$CuCl$	44.14	57.21	$CuCl$
10.8	3.15	"	55.10	44.10	$NaCl$
20.7	7.30	"	56.80	41.70	"
27	40.60	"	50.90	18.70	"
36.48	49.10	"			

**SOLUBILITY OF CUPROUS CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE AT 22° AND VICE VERSA.**

(Brønsted, 1912.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$KCl$	$CuCl$		$KCl$	$CuCl$		$KCl$	$CuCl$	
3.87	0.115	$CuCl$	21.64	13.32	$CuCl$	24.04	4.53	$CuCl_2 \cdot KCl$
6.56	0.405	"	23.84	17.23	"	25.03	3.14	"
8.24	0.861	"	25.24	21.47	"	26.28	2.20	"
11.33	2.19	"	23.87	15.48	$CuCl_2 \cdot KCl$	27.06	1.60	"
15.30	4.80	"	23.57	13.99	"	26.68	1.21	$KCl$
17.47	7.19	"	23.50	11.39	"	26.32	0.58	"
20.31	10.21	"	23.49	7.35	"	25.68	0	"



SOLUBILITY OF CUPRIC CHLORIDE IN AQUEOUS SOLUTIONS OF MERCURIC  
CHLORIDE AT 35° AND VICE VERSA.

(Schreinemakers and Thonus, 1912.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
HgCl <sub>2</sub>	CuCl <sub>2</sub>		HgCl <sub>2</sub>	CuCl <sub>2</sub>	
0	44.47	CuCl <sub>2</sub> ·2H <sub>2</sub> O	52.54	18.46	HgCl <sub>2</sub>
21.03	33.5	"	52.81	18.06	"
37.30	26.07	"	51.03	14.73	"
44.47	23.31	"	49.50	5.94	"
50.47	21.50	" + HgCl <sub>2</sub>	23.87	2.64	"
52.44	19.40	HgCl <sub>2</sub>	8.51	0	"

SOLUBILITY OF COPPER CHLORIDE AND POTASSIUM CHLORIDE DOUBLE  
SALTS AND MIXTURES IN WATER.

(Meyerhoffer — Z. physik. Chem. 5, 102, '90.)

°.	Cl per 1 Gram Solution.		Mols. per 100 Mols. H <sub>2</sub> O.		Solid Phase.
	Present as CuCl <sub>2</sub>	Present as KCl	CuCl <sub>2</sub>	KCl	
39.4	0.120	0.107	5.56	9.93	CuCl <sub>2</sub> ·KCl·2H <sub>2</sub> O + KCl
49.9	0.129	0.115	6.39	11.4	"
60.4	0.142	0.125	7.71	13.6	"
79.1	0.168	0.142	11.1	18.8	"
90.5	0.188	0.154	14.9	24.4	"
93.7	0.194	0.156	16.2	26.0	CuCl <sub>2</sub> ·KCl + KCl
98.8	0.197	0.162	17.5	28.7	"
0	0.214	0.021	9.84	1.94	CuCl <sub>2</sub> ·KCl·2H <sub>2</sub> O + CuCl <sub>2</sub> ·H <sub>2</sub> O
39.6	0.232	0.049	12.9	5.44	"
50.1	0.233	0.059	13.7	6.90	"
52.9	0.241	0.062	14.8	7.63	"
60.2	0.246	0.066	15.8	8.49	CuCl <sub>2</sub> ·KCl + CuCl <sub>2</sub> ·H <sub>2</sub> O
72.6	0.255	0.063	16.8	8.35	"
64.2	...	...	14.9	11.6	CuCl <sub>2</sub> ·KCl·2H <sub>2</sub> O + CuCl <sub>2</sub> ·KCl
72.5	...	...	14.8	15.0	CuCl <sub>2</sub> ·KCl

SOLUBILITY OF CUPRIC CHLORIDE IN AQUEOUS SOLUTIONS OF SODIUM  
CHLORIDE AT 30° AND VICE VERSA.

(Schreinemakers and de Baat, 1908-09.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
NaCl	CuCl <sub>2</sub>		NaCl	CuCl <sub>2</sub>	
0	43.95	CuCl <sub>2</sub> ·2H <sub>2</sub> O	12.25	32.40	NaCl
3.10	41.14	"	13.54	28.64	"
4.28	41.06	"	15.40	23.72	"
6.41	39.40	"	18.44	16.98	"
10.25	36.86	" + NaCl	20.61	11.03	"
12.02	32.38	NaCl	26.47	0	"



## SOLUBILITY OF CUPRIC CHLORIDE IN AQUEOUS ALCOHOL AT 11.5°.

(Böttker, 1897.)

10 gms. of  $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$  and the indicated amounts of  $\text{CuCl}_2$  were added to 20 cc. portions of alcohol. The solutions shaken two hours and 5 cc. portions withdrawn.

Vol. % Alcohol.	Gms. $\text{CuCl}_2$ Added.	Gms. per 5 cc. Solution.		Vol. % Alcohol.	Gms. $\text{CuCl}_2$ Added.	Gms. per 5 cc. Solution.	
		$\text{H}_2\text{O}$ .	$\text{CuCl}_2$ .			$\text{H}_2\text{O}$ .	$\text{CuCl}_2$ .
89.3	0	0.794	1.137	99.3	0.223	0.330	1.295
92.3	0	0.648	1.090	99.3	0.887	0.247	1.639
96.3	0	0.478	1.116	99.3	1.540	0.191	2.086
99.3	0	0.369	1.208	99.3	1.957	0.164	2.400

## SOLUBILITY OF CUPRIC CHLORIDE IN SEVERAL SOLVENTS.

(Exard — Ann. chim. phys. [7] 2, 564, '04; de Bruyn — Z. physik. Chem. 10, 783, '02; de Coninck — Compt. rend. 131, 59, '00; St. von Laszczyński — Ber. 27, 2285, '04.)

Solvent.	Grams $\text{CuCl}_2$ per 100 Grams Sat. Solution at:				
	0°.	15°.	20°.	40°.	80°.
Methyl Alcohol	36	40.5 (de B.)	36.5	37.0	...
Ethyl Alcohol	32	35.0 (de B.)	35.7	39.0	...
Propyl Alcohol	29	...	30.5	30.5	...
Iso Propyl Alcohol	...	...	...	16.0	30.0
n Butyl Alcohol	15	...	15.3	16.0	16.5
Allyl Alcohol	23	...	23.0	...	...
Ethyl Formate	10	...	9.0	8.0	...
Ethyl Acetate	...	...	3.0	2.5	1.3 (72°)
Acetone (abs.)	8.86*	8.92†	2.88 (18°)	...	1.40 (56°)
Acetone (80%)	...	...	18.9‡	...	...
Ether	...	0.043 (11°)	0.11	...	...

\* ( $\text{CuCl}_2 \cdot 2\text{Aq.}$ )† ( $\text{CuCl}_2 \cdot 2\text{Aq.}$ )‡ (23°  $\text{CuCl}_2 \cdot 2\text{Aq.}$ )

For the solubility of cupric chloride in mixtures of a number of organic solvents, see de Coninck.

Solvent.	t°.	Gms. $\text{CuCl}_2$ per 100 Gms. Sat. Sol.	Sp. Gr. Sat. Sol.	Authority.
Acetonitrile	18	1.57	...	(Naumann and Schier, 1914.)
Ethyl Acetate	18	0.4	0.9055	(Naumann, 1904.)
Methyl Acetate	18	0.55	0.939	(Naumann, 1909.)
Anhydrous Hydrazine ord. temp.	5 (decomp.)	...	...	(Welsh and Broderson, 1915.)

## SOLUBILITY OF CUPROUS CHLORIDE IN ACETONITRILE. (Naumann and Schier, 1914.)

100 gms. acetonitrile of boiling point 81.6° dissolve 13.33 gms.  $\text{CuCl}$  at 18°.

## SOLUBILITY OF CUPRIC CHLORIDE IN PYRIDINE.

(Mathews and Spero, 1917.)

t°.	Gms. $\text{CuCl}_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{CuCl}_2$ per 100 Gms. Sat. Sol.	Solid Phase.
-17.3	0.140	$\text{CuCl}_2 \cdot 6\text{C}_5\text{H}_5\text{N}$	45	0.422	$\text{CuCl}_2 \cdot 2\text{C}_5\text{H}_5\text{N}$
-12.1	0.195	"	53	0.493	"
-10	0.295	" (unstable)	60	0.565	" (unstable)
-8.9 tr. pt.	0.270	" + $\text{CuCl}_2 \cdot 2\text{C}_5\text{H}_5\text{N}$	62	0.616	"
+ 2	0.275	$\text{CuCl}_2 \cdot 2\text{C}_5\text{H}_5\text{N}$	58 tr. pt.	...	" + $2\text{CuCl}_2 \cdot 3\text{C}_5\text{H}_5\text{N}$
10	0.293	"	63	0.543	$2\text{CuCl}_2 \cdot 3\text{C}_5\text{H}_5\text{N}$
25	0.348	"	75	0.631	"
35	0.382	"	95	0.917	"



# COPPER CHLORIDE

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## DISTRIBUTION OF CUPRIC CHLORIDE BETWEEN AQ. HCl AND ETHER

When 1 gm. of copper as chloride is dissolved in 100 cc. of 10% HCl and shaken with 100 cc. of ether, 0.05% of the metal enters the ethereal layer. (Mylin, 1911.)

## COPPER Ammonium CHLORIDE $\text{CuCl}_2 \cdot \text{NH}_4\text{Cl}$

SOLUBILITY IN ABSOLUTE ALCOHOL AT 25°. (Foote and Walden, 1911.)

Gms. per 100 Gms. Sat. Sol.	NH <sub>4</sub> Cl.	Solid Phase.
CuCl <sub>2</sub> .		
4.7	not det.	NH <sub>4</sub> Cl + CuCl <sub>2</sub> · NH <sub>4</sub> Cl
6.45	"	CuCl <sub>2</sub> · NH <sub>4</sub> Cl
12.90	"	"
34.7	"	" + CuCl <sub>2</sub> · C <sub>2</sub> H <sub>5</sub> OH

## COPPER Potassium CHLORIDE $\text{CuCl}_2 \cdot \text{KCl}$

SOLUBILITY IN ABSOLUTE ALCOHOL AND IN ACETONE AT 25°. (Foote and Walden, 1911.)

In Absolute Alcohol.			In Acetone.		
Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
CuCl <sub>2</sub> .	KCl.		CuCl <sub>2</sub> .	KCl.	
1.40	0.28	KCl + CuCl <sub>2</sub> · KCl	0.34	0.38	KCl + CuCl <sub>2</sub> · KCl
2.15	not. det.	CuCl <sub>2</sub> · KCl	0.48	not det.	CuCl <sub>2</sub> · KCl
5.25	"	"	1.50	"	"
30.16	"	"	2.06	"	"
34.45	0.21	" + CuCl <sub>2</sub> · C <sub>2</sub> H <sub>5</sub> OH	2.40	0.27	" + CuCl <sub>2</sub> · C <sub>2</sub> H <sub>5</sub> OH
33.97	0	CuCl <sub>2</sub> · C <sub>2</sub> H <sub>5</sub> OH			

Freezing-point data (solubility, see footnote, p. 1) are given for the following mixtures of cuprous chloride and other chlorides.

CuCl + CuCl <sub>2</sub>	(Sandonnini, 1912 (a)).
" + FeCl <sub>2</sub>	(Hermann, 1911.)
" + PbCl <sub>2</sub>	"
" + LiCl	(Sandonnini, 1911, 1914; Korreng, 1914.)
" + RbCl	(Sandonnini, 1914; Sandonnini and Aureggi, 1912.)
" + AgCl	(Sandonnini, 1911, 1914; Poma and Gabbi, 1911, 1912.)
" + KCl	(Sandonnini, 1911, 1914; Korreng, 1914; Sackur, 1913; Poma and Gabbi, 1911, 1912.)
" + NaCl	(Sandonnini, 1911, 1914; Korreng, 1914; Sackur, 1913; de Cesari, 1911.)
" + TiCl	(Sandonnini, 1911, 1914.)
" + SnCl <sub>2</sub>	(Hermann, 1911.)
" + ZnCl <sub>2</sub>	"

Freezing-point lowering data for mixtures of CuCl + Cu<sub>2</sub>O and CuCl + Cu are given by Truthe, 1912.

## COPPER Potassium CITRATE $\text{CuK}_4[(\text{COOCH}_3)_2\text{C}(\text{OH})\text{COO}]_2$

100 cc. sat. solution in H<sub>2</sub>O contain 43.3 gms. of the salt at 10°. (Pickering, 1911.)

## COPPER CYANIDE (ous) $\text{Cu}_2(\text{CN})_2$

Freezing-point data for  $\text{Cu}_2(\text{CN})_2$  + KCN and  $\text{Cu}_2(\text{CN})_2$  + NaCN are given by Truthe (1912).

## COPPER HYDROXIDE (ic) $\text{Cu}(\text{OH})_2$

SOLUBILITY IN AQUEOUS SOLUTIONS OF AMMONIA AT 18°. (Dawson, 1909.)

Mols. NH <sub>3</sub> per Liter.	Gm. Atoms Cu per Liter.	Mols. NH <sub>3</sub> per Liter.	Gm. Atoms Cu per Liter.
0.2	0.00054	3	0.0548
0.5	0.0033	4	0.0784
1	0.0109	5	0.1041
1.5	0.0204	6	0.1254
2	0.0314	8	0.1599
2.5	0.0442	9.96	0.1787

Three series of results at 25°, somewhat higher than the above, are given by Bonsdorff, 1904.

Data showing the effect of increasing amounts of  $(\text{NH}_4)_2\text{SO}_4$ ,  $\text{Ba}(\text{OH})_2$ , NaOH and of  $\text{Na}_2\text{SO}_4$  upon the solubility of cupric hydroxide in aqueous ammonium solution at 18°, are given by Dawson, 1909 a.



**CUPROUS IODATE** (ic)  $\text{Cu}(\text{IO}_3)_2 \cdot \text{H}_2\text{O}$ .

One liter sat. aqueous solution contains 1.36 gms.  $\text{Cu}(\text{IO}_3)_2$  at  $25^\circ$ , determined by measurement of single potential differences against a 0.1 *N* calomel electrode. (Spencer, 1913.)

**CUPROUS IODIDE** (ic)  $\text{CuI}_2$ .

One liter sat. aqueous solution contains 11.07 gms.  $\text{CuI}_2$  at  $20^\circ$ . (Fedotieff, 1911-12.)

**CUPROUS IODIDE** (ous)  $\text{Cu}_2\text{I}_2$ .

**SOLUBILITY OF CUPROUS IODIDE IN AQUEOUS SOLUTIONS OF AMMONIUM BROMIDE AND OF POTASSIUM BROMIDE.**  
(Kohn, 1909; Kohn, and Klein, 1912.)

Results for Aq. $\text{NH}_4\text{Br}$ at $20^\circ$ .				Results for Aq. $\text{KBr}$ Solutions.			
Normality of $\text{NH}_4\text{Br}$ Sol.	Gms. $\text{Cu}_2\text{I}_2$ per 1000 cc. Sat. Sol.	t°.		Normality of $\text{KBr}$ Sol.	Gms. $\text{Cu}_2\text{I}_2$ per 1000 cc. Sat. Sol.	t°.	
2	1.0068	19.5		2	1.467	23	3
3	3.6540	24		2	1.558	22	4
4	6.0588	19.5		3	3.409	22	4

**SOLUBILITY OF CUPROUS IODIDE IN AQUEOUS SOLUTIONS OF IODINE AT  $20^\circ$  AND VICE VERSA.** (Fedotieff, 1910-11.)

Gms. per Liter.			Solid Phase.			Gms. per Liter.			Solid Phase.		
Cu	I.		Cu	I.		Cu	I.		Cu	I.	
0.285	0.5848		CuI	0.964	5.0854	CuI	0.748	4.7112	I		
1.482	1.3053		"	1.032	5.6854	"	0.606	3.8562	"		
1.583	1.9218		"	1.090	6.2816	"	0.448	2.9493	"		
1.678	2.5573		"	1.112	6.5301	"	0.300	2.0689	"		
1.756	3.2042		"	1.232	7.6529	" + I	0.159	1.2304	"		
1.844	3.9539		"	1.040	6.4440	I at $0^\circ$	0.925	5.4609	CuI + I		
1.898	4.4359		"	0.898	5.5941	" at $40^\circ$	1.658	11.3658	"		

Constant agitation and temperature. Iodine determined by thiosulfate titration; copper, electrolytically.

Additional data for the solubility of cuprous iodide in aqueous solutions of iodine in presence of acids and salts at  $25^\circ$ , are given by Bray and MacKay (10). These authors state that cuprous iodide is difficultly soluble in water, in the presence of iodine a considerable amount dissolves, owing to the formation of cupric iodide and tri-iodide.

30 gms. acetonitrile dissolve 3.52 gms.  $\text{Cu}_2\text{I}_2$  at  $18^\circ$ . (Naumann and Schier, 1914.) Freezing-point lowering data for mixtures of  $\text{CuI} + \text{AgI}$  are given by Quercigh, '14.

**CUPRIC NITRATE** (ic)  $\text{Cu}(\text{NO}_3)_2$ .

**SOLUBILITY IN WATER.** (Funk, 1900.)

Gms. $\text{Cu}(\text{NO}_3)_2$ per 100 Gms. Solution.		Mols. $\text{Cu}(\text{NO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .		Solid Phase.	t°.	Gms. $\text{Cu}(\text{NO}_3)_2$ per 100 Gms. Solution.		Mols. $\text{Cu}(\text{NO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .		Solid Phase.
3	36.08	5.42		$\text{Cu}(\text{NO}_3)_2 \cdot 9\text{H}_2\text{O}$	20	55.58	12			$\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
3	40.92	6.65		"	26.4	63.39	16.7			"
1	39.52	6.27		$\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	25	60.01	14.4			$\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$
3	45	7.87		"	40	61.51	15.2			"
3	48.79	9.15		"	60	64.17	17.2			"
3	53.86	11.20		"	80	67.51	20			"
					114.5	77.59	33.3			"

Density of solution saturated at  $18^\circ = 1.681$ .

10 gms.  $\text{H}_2\text{O}$  dissolve 127.4 gms.  $\text{Cu}(\text{NO}_3)_2$  at  $20^\circ$ ,  $d_{20}$  sat. sol. = 1.688. (Fedotieff, 1911-12.)

Data for the solubility of copper nitrate in aq. ammonia solutions are given by Casevich, 1913.

Data for the solubility of copper nitrate in aq. solutions of copper sulfate or sodium nitrate at  $20^\circ$  are given by Massink, 1916 and 1917.

10 cc. anhydrous hydrazine dissolve 1 gm. copper nitrate, with decomposition at room temp. (Welsh and Broderson, 1915.)



**SOLUBILITY OF COPPER SULFATE IN AQUEOUS SOLUTIONS OF AMMONIUM  
SULFATE AT 0°.**  
(Engel, 1886.)

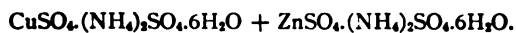
Milligram Equiv. per 10 cc. Solution.		Sp. Gr. of Solutions.	Grams per 100 cc. Solution.	
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	CuSO <sub>4</sub> .		(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	CuSO <sub>4</sub> .
0	18.52	1.144	0	14.79
5.45	20.15	1.190	3.61	16.09
7	10.5	1.108	4.63	8.38
7.4	9.1	1.099	4.90	7.26
8.45	6.425	1.0815	5.59	5.13
11.35	3.7	1.071	7.51	2.95
18.6	1.178	1.082	12.31	0.94
31.2	1	1.116	20.65	0.80

**SOLUBILITY OF MIXTURES OF COPPER AMMONIUM SULFATE AND NICKEL  
AMMONIUM SULFATE IN WATER AT 13°-14°:**  
(Fock, 1897.)



Mol. % in Solution.		Mols. per 100 Mols. H <sub>2</sub> O.		Mol. % in Solid Phase.	
Cu Salt.	Ni Salt.	Cu Salt.	Ni Salt.	Cu Salt.	Ni Salt.
0	100	0	0.521	0	100
33.34	66.66	0.1476	0.295	10.29	89.71
56.05	43.95	0.2664	0.2089	30.59	69.41
73.89	26.20	0.4165	0.1449	52.23	47.77
79.92	20.08	0.4785	0.1202	78.80	21.20
100	0	1.0350	0	100	0

**SOLUBILITY OF MIXTURES OF COPPER AMMONIUM SULFATE AND ZINC  
AMMONIUM SULFATE IN WATER AT 13°-14°.**  
(Fock, 1897.)



Mol. % in Solution.		Mols. per 100 Mols. H <sub>2</sub> O.		Mol. % in Solid Phase.	
Cu Salt.	Zn Salt.	Cu Salt.	Zn Salt.	Cu Salt.	Zn Salt.
4.97	95.03	0.0422	0.8069	2.39	97.61
10.65	89.35	0.0666	0.5638	4.52	95.48
19.24	80.76	0.1218	0.5115	90.3	90.97
30.19	69.81	0.2130	0.4924	14.67	85.33
44.44	55.56	0.3216	0.4022	22.62	77.38
100	0	1.035	0	100	0

**SOLUBILITY OF COPPER SULFATE IN AQUEOUS SOLUTIONS OF MAGNESIUM  
SULFATE AT 0°.**  
(Diacon, 1866.)

Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.	Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.
CuSO <sub>4</sub> .	MgSO <sub>4</sub> .		CuSO <sub>4</sub> .	MgSO <sub>4</sub> .	
0	26.37	MgSO <sub>4</sub> ·6H <sub>2</sub> O	12.03	15.67	CuSO <sub>4</sub> ·5H <sub>2</sub> O
2.64	25.91	"	13.61	8.64	"
4.75	25.30	"	14.99	0	"
9.01	23.30	MgSO <sub>4</sub> ·6H <sub>2</sub> O + CuSO <sub>4</sub> ·5H <sub>2</sub> O			



SOLUBILITY OF COPPER SULFATE IN AQUEOUS SOLUTIONS OF COPPER  
CHLORIDE AT 30°.  
(Schreinemakers, 1910.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
CuCl <sub>2</sub> .	CuSO <sub>4</sub> .		CuCl <sub>2</sub> .	CuSO <sub>4</sub> .	
0	20.32	CuSO <sub>4</sub> ·5H <sub>2</sub> O	39.48	3.21	CuSO <sub>4</sub> ·5H <sub>2</sub> O
6.58	13.62	"	42.62	2.90	" + CuCl <sub>2</sub> ·2H <sub>2</sub> O
15.68	8.93	"	43.25	1.14	CuCl <sub>2</sub> ·2H <sub>2</sub> O
25.67	4.77	"	43.95	0	"

DATA FOR EQUILIBRIUM IN COMPLEX SYSTEMS CONTAINING COPPER SULFATE

System.			Authority.
CuSO <sub>4</sub>	+ CuCl <sub>2</sub>	+ (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> + NH <sub>4</sub> Cl + H <sub>2</sub> O	(Schreinemakers, 1910.)
"	+	" + K <sub>2</sub> SO <sub>4</sub> + KCl + H <sub>2</sub> O	(Schreinemakers and de Baat, 1914.)
"	+	" + Na <sub>2</sub> SO <sub>4</sub> + NaCl + H <sub>2</sub> O	(Schreinemakers, 1911.)
"	+	Li <sub>2</sub> SO <sub>4</sub> + (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> + H <sub>2</sub> O	(Schreinemakers, 1909.)

SOLUBILITY OF COPPER SULFATE IN AQUEOUS SOLUTIONS OF LITHIUM  
SULFATE AT 30°.

(Schreinemakers, 1908, 1909.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
Li <sub>2</sub> SO <sub>4</sub> .	CuSO <sub>4</sub> .		Li <sub>2</sub> SO <sub>4</sub> .	CuSO <sub>4</sub> .	
0	20.32	CuSO <sub>4</sub> ·5H <sub>2</sub> O	17.92	11.04	CuSO <sub>4</sub> ·5H <sub>2</sub> O
3.54	17.59	"	20.55	10.05	" + Li <sub>2</sub> SO <sub>4</sub> ·H <sub>2</sub> O
6.08	16.10	"	22.23	6.41	Li <sub>2</sub> SO <sub>4</sub> ·H <sub>2</sub> O
11.94	13.55	"	23.59	3.39	"
15.72	12.14	"	25.24	0	"

SOLUBILITY OF COPPER SULFATE IN AQUEOUS SOLUTIONS OF LITHIUM  
OTHER CHLORIDES AT 25°.

(Herz, 1910.)

In Lithium Chloride.		In Potassium Chloride.		In Rubidium Chloride.		In Sodium Chloride.	
Gms. per 100 cc. Sat. Sol.		Gms. per 100 cc. Sat. Sol.		Gms. per 100 cc. Sat. Sol.		Gms. per 100 cc. Sat. Sol.	
LiCl.	CuSO <sub>4</sub> .	KCl.	CuSO <sub>4</sub> .	RbCl.	CuSO <sub>4</sub> .	NaCl.	CuSO <sub>4</sub> .
3.10	20.06	4.19	23.80	0	22.34	2.10	22.4
5.93	18.78	8.75	24.92	13.22	25.02	7.72	22.7
12	17.03	17.50	29.03			14.79	24.05

SOLUBILITY OF COPPER POTASSIUM SULFATE CuK<sub>2</sub>(SO<sub>4</sub>)<sub>2</sub>·6H<sub>2</sub>O IN WATER AT 25°.

100 gms. H<sub>2</sub>O dissolve 11.14 gms. CuK<sub>2</sub>(SO<sub>4</sub>)<sub>2</sub>.

(Trevor, 1891.)

Additional data for the system Copper sulfate + Potassium sulfate + H<sub>2</sub>O are given by Meerburg, 1909.

Data for the solubility in water of mix-crystals of copper sulfate and manganese sulfate at 0° and 17°, and of copper sulfate and zinc sulfate at 12°, 18°, 25°, 35°, 40° and 45°, are given by Hollemann, 1905-06.



**COPPER SULFATE, MANGANESE SULFATE, MIXED CRYSTALS AT 25°.**  
(Stortenbecker, 1900.)

g. per 100 Gms. H <sub>2</sub> O.		Mols. per 100 Mols. H <sub>2</sub> O.		Mol. % Cu in Solution.	Mol. % Cu in Crystals.
CuSO <sub>4</sub> .	MnSO <sub>4</sub> .	Cu.	Mn.		
Triclinic Crystals with 5H <sub>2</sub> O.					
0 - 2	0	2.282	0	100	100
0 - 76	3.69	2.23	0.44	90.5	99.3
				83.5	...
				74.1	97.3
				57.7	95.1
				31.0	81.3
0 - 65	31.52	1.54	3.76	29.0	...
				26.1	70.4
0 - 61	39.41	1.31	4.70	21.8	...
				21.2	42.6
				20.0	34.4
0 - 39	46.77	1.06	5.59	15.9	22.9
0 - 47	53.39	0.73	6.37	13.45*	15.2*
0 - 01	58.93	0.34	7.03	10.27	10.5
				5.0	4.9
0 - 0	61.83	0.0	7.375	4.6	...
				2.31	2.15
<del>0 - 0</del> Monoclinic Crystals with 7H <sub>2</sub> O.				0.0	100.0
0 - 39	46.77	1.06	5.58	20.0	28.2
				15.9	23.5
				13.45	20.8
0 - 47	53.39	0.73	6.37	10.27	16.0
0 - 0	67.07 ±	0.0	8 ± *	4.6*	5.8*
				0.0	100

\* Indicates points of labil equilibrium.

**COPPER SULFATE, ZINC SULFATE, MIXED CRYSTALS IN WATER AT 18°.**  
(Stortenbecker, 1897.)

g. per 100 Mols. H <sub>2</sub> O.		Mol. % Cu in Solution.	Mol. % Cu in Crystals.	
Cu.	Zn.			
2.28	0	100	100	} Triclinic Crystals with 5H <sub>2</sub> O.
1.83	2.08	46.8	94.9	
1.41	3.60	28.1		
1.19	5.01	19.2	77.9	
1.86	3.36	36.2	40.4	
1.22	4.45	21.5	29.5-31.9	} Monoclinic Crystals with 7H <sub>2</sub> O.
1.01	4.72	17.6	24.1-28.	
0.82	5.03	14.0	19.0-22.	
0.51	5.59	8.36	12.4-14.9	
0.30	5.56	4.87	7.02	
0.0	6.42	0.0	0	} Rhombic Crystals with 7H <sub>2</sub> O.
1.19	5.01	19.2	5.01	
0.51	5.59	8.36	1.97	
0.267	5.77	4.42	1.15	
0.0	5.94	0.0	0.00	



**SOLUBILITY OF COPPER SULFATE, SODIUM SULFATE MIXTURES IN WATER.**  
(Koppel, 1901-02; Massol and Malmes, 1901.)

t°.	Gms. per 100 Gms. Solution.		Mols. per 100 Mols. H <sub>2</sub> O.		Solid Phase.
	CuSO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	CuSO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	
0	13.40	6.23	1.88	0.98	CuSO <sub>4</sub> ·5H <sub>2</sub> O + Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O
10	14.90	9.46	2.23	1.56	"
15	15.18	11.64	2.34	2.02	"
17.7	14.34	13.34	2.24	2.34	CuSO <sub>4</sub> ·Na <sub>2</sub> SO <sub>4</sub> ·2H <sub>2</sub> O
23	14.36	12.76	2.23	2.21	"
40.15	13.73	12.26	2.10	2.10	"
17.7	14.99	13.48	2.37	2.39	CuSO <sub>4</sub> ·Na <sub>2</sub> SO <sub>4</sub> ·2H <sub>2</sub> O + CuSO <sub>4</sub> ·5H <sub>2</sub> O
23	16.41	11.35	2.57	1.99	"
40.15	20.56	8	3.25	1.47	"
18	13.53	13.84	2.10	2.41	CuSO <sub>4</sub> ·Na <sub>2</sub> SO <sub>4</sub> ·2H <sub>2</sub> O + Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O
20	11.34	15.70	1.76	2.73	"
25	6.28	21.20	0.98	3.70	"
30	2.607	28.38	0.43	5.21	"
33.9	1.475	32.30	0.25	6.18	"
37.2	1.494	31.96	0.25	6.08	"
30	5.38	22.17	...	...	CuSO <sub>4</sub> ·Na <sub>2</sub> SO <sub>4</sub> ·2H <sub>2</sub> O + increasing amts. of Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O
30.1	3.69	25.37			
30	1.57	32.09			

Data for the system copper sulfate, sodium sulfate, water, at 20° and 35° are given by Massink, 1916, 1917.

**SOLUBILITY OF COPPER SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC  
ACID AT 0°.** (Engel, 1887.)

Milligram Equiv. per 10 Gms. H <sub>2</sub> O.		Sp. Gr. of Solutions.	Grams per 100 Grams H <sub>2</sub> O.	
H <sub>2</sub> SO <sub>4</sub> .	CuSO <sub>4</sub> .		H <sub>2</sub> SO <sub>4</sub> .	CuSO <sub>4</sub> .
0	18.6	1.144	0	14.85
4.14	17.9	1.143	2.03	14.29
14.6	19.6	1.158	7.16	15.65
31	12.4	1.170	15.20	9.90
54.2	8.06	1.195	26.57	6.43
56.25	7.75	1.211	27.57	6.19
71.8	5	1.224	35.2	3.99

**SOLUBILITY OF COPPER SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID  
AT 25°.** (Bell and Taber, 1908; Foote, 1915.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
H <sub>2</sub> SO <sub>4</sub> .	CuSO <sub>4</sub> .		H <sub>2</sub> SO <sub>4</sub> .	CuSO <sub>4</sub> .	
0	18.47	CuSO <sub>4</sub> ·5H <sub>2</sub> O	55.72	2.13	CuSO <sub>4</sub> ·3H <sub>2</sub> O + CuSO <sub>4</sub> H <sub>2</sub> O
11.14	12.62	"	61.79	0.95	CuSO <sub>4</sub> ·H <sub>2</sub> O
25.53	5.92	"	77.93	0.17	"
36.77	3.25	"	83.29	0.15	"
42.15	2.63	"	85.46	0.19	"
47.66	2.59	"	85.76	0.43	" + CuSO <sub>4</sub>
49	2.83	" + CuSO <sub>4</sub> ·3H <sub>2</sub> O	86.04	0.40	CuSO <sub>4</sub>
50.23	2.70	CuSO <sub>4</sub> ·3H <sub>2</sub> O	92.70	0.19	"
54.78	2.19	"			



**SOLUBILITY OF COPPER SULFATE IN METHYL AND ETHYL ALCOHOL, ETC.**  
(de Bruyn, 1892; de Coninck, 1905.)

Solvent.	t°.	Gms. per 100 Gms. Solv.		SOLUBILITY IN AQUEOUS ALCOHOL AT 15°.	
		CuSO <sub>4</sub> .	CuSO <sub>4</sub> ·5H <sub>2</sub> O.		
Methyl Alcohol Abs.	18	1.05	15.6	(Schiff, 1861.)	
" " 93.5%	18	...	0.93	Wt. % Alcohol.	Gms. CuSO <sub>4</sub> ·5H <sub>2</sub> O per 100 g. Solvent.
" " 50%	18	...	0.40		
" " Abs.	3	...	13.4		
Ethyl Alcohol Abs.	3	...	1.1	10	15.3
Glycol	14.6	...	7.6*	20	3.2
Glycerol	15.5	...	30	40	0.25
Glycerol	15-16	...	36.3	(Ossendowski, 1907.)	
95% Formic Acid	18.5	...	0.05	(Aschan, 1913.)	
Anhy. Hydrazine	ord. t. 2	...	†	(Welsh and Broderson, 1915.)	

\* Per 100 gms. solution.

† decomp.

Data for the solubility of copper sulfate in methyl alcohol are given by Carrara and Minozzi, 1897.

**COPPER SULFIDE** (ic) CuS.

One liter of water dissolves 0.00033 gm. CuS at 18°, determined by the conductivity method. (Weigel, 1906; see also Bruner and Zawadski, 1909.)

100 cc. sat aq. sodium sulfide solution (of  $d = 1.225$ ) dissolve 0.0032 gm. CuS. (Holland, 1897.)

**SOLUBILITY OF COPPER SULFIDE IN AQUEOUS SUGAR SOLUTIONS.**  
(Stolle, 1900.)

% Sugar in Solvent.	Gms. CuS per Liter of Aq. Sugar Solution at:		
	17.5°.	45°.	75°.
10	0.5672	0.3659	1.1345
30	0.8632	0.7220	1.2033
50	0.9076	1.0589	1.2809

**COPPER SULFIDE** (ous) Cu<sub>2</sub>S.

Freezing-point lowering data (solubility, see footnote, p. 1) for mixtures of Cu<sub>2</sub>S + Ag<sub>2</sub>S, Cu<sub>2</sub>S + PbS and Cu<sub>2</sub>S + ZnS are given by Friedrich, 1907-08. Results for Cu<sub>2</sub>S + Sb<sub>2</sub>S<sub>3</sub> are given by Chikashigi and Yamanchi, 1916. Data for Cu<sub>2</sub>S + FeS are given by Shad and Bornemann, 1916.

**COPPER SULFONATES.**

100 gms. H<sub>2</sub>O dissolve 0.25 gm. copper 2-phenanthrene monosulfonate at 20°.

" " " 0.09 " " 3- " " "

" " " 0.26 " " 10- " " "

(Sandquist, 1912.)

**COPPER TARTRATE** CuC<sub>4</sub>O<sub>6</sub>H<sub>4</sub>·3H<sub>2</sub>O.

**SOLUBILITY IN WATER.**  
(Cantoni and Zachoder, 1905.)

t°.	Gms. CuC <sub>4</sub> O <sub>6</sub> H <sub>4</sub> ·3H <sub>2</sub> O per 100 cc. Solution.	t°.	Gms. CuC <sub>4</sub> O <sub>6</sub> H <sub>4</sub> ·3H <sub>2</sub> O per 100 cc. Solution.	t°.	Gms. CuC <sub>4</sub> O <sub>6</sub> H <sub>4</sub> ·3H <sub>2</sub> O per 100 cc. Solution.
15	0.0197	40	0.1420	65	0.1767
20	0.0420	45	0.1708	70	0.1640
25	0.0690	50	0.1920	75	0.1566
30	0.0890	55	0.2124	80	0.1440
35	0.1205	60	0.1970	85	0.1370



# COPPER THIOCYANATE

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## COPPER THIOCYANATE (ic) $\text{Cu}(\text{SCN})_2$ .

SOLUBILITY IN AQUEOUS AMMONIA SOLUTIONS AT 25° AND AT 40°.  
(Horn, 1907.)

$d_{20}^4$ Sat. Sol.	Results at 25°.			Results at 40°.		
	Gms. per 100	Gms. Sat. Sol.	Solid Phase.	Gms. per 100	Gms. Sat. Sol.	Solid Phase.
	$\text{NH}_3$	$\text{Cu}(\text{SCN})_2$		$\text{NH}_3$	$\text{Cu}(\text{SCN})_2$	
1.0082	0.79	2.45	$\text{Cu}(\text{SCN})_{2-2}\text{NH}_3$	0.94	2.81	$\text{Cu}(\text{SCN})_{2-2}\text{NH}_3$
1.0166	1.98	4.08	"	1.77	4.18	"
1.0213	2.50	5.11	"	2.57	6.55	"
1.0171	4.26	5.96	$\text{Cu}(\text{SCN})_{2-4}\text{NH}_3$	3.52	8.76	"
1.0151	5.35	6.22	"	4.35	11.78	$\text{Cu}(\text{SCN})_{2-4}\text{NH}_3$
1.0134	6.39	6.59	"	5.50	12.07	"
1.0070	9.93	7.98	"	7.58	12.99	"
0.9987	16.55	11.24	"	13.98	16.58	"
0.9985	21.47	15.22	"	18.02	19.76	"

## COUMARIN $\text{C}_9\text{H}_6\text{O}_2$ .

100 gms. water	dissolve 0.01 gm. coumarin at 20°-25°.	(Dehn, 1917.)
" pyridine	" 87.7 gms.	" " " "
" 50% aq. pyridine	" 60.1 "	" " " "
" chloroform	" 49.4 "	" 25°. (Osaka, 1903-08.)

Freezing-point lowering data for mixtures of coumarin and sulfuric acid are given by Kendall and Carpenter, 1914.

## CRESOLS $\text{C}_6\text{H}_4(\text{OH})\text{CH}_3$ *o*, *m* and *p*.

SOLUBILITY OF EACH SEPARATELY IN WATER.  
(At 20°, Vaubel, 1895; Sidgwick, Spurrell and Davies, 1915.)

Determinations by synthetic method; melting-point of *o* = 29.9°, of *m* = 4°, of *p* = 33.8°. Triple point for *o* = 87 and 2.5 gms. per 100 gms. sat. sol. at 8°; triple point for *p* = 86 and 2 gms. per 100 gms. sat. sol. at 8.7°.

t°.	Gms. per 100 Gms. Sat. Solution.			t°.	Gms. per 100 Gms. Sat. Solution.		
	<i>o</i> Cresol.	<i>m</i> Cresol.	<i>p</i> Cresol.		<i>o</i> Cresol.	<i>m</i> Cresol.	<i>p</i> Cresol.
20	2.45	2.18	1.94	120	6.22	7	6.58
40	3.08	2.51	2.26	130	6.70	8.86	9
50	3.22	2.72	2.43	140	7.67	12.3	15.9
60	3.40	2.98	2.69	143.5 crit. t.	...	...	∞
70	3.74	3.35	3.03	147 crit. t.	...	∞	
80	4.22	3.80	3.52	150	11.1		
90	4.80	4.43	4.16	160	23.7		
100	5.30	5.47	5.10	162.8 crit. t.	∞		
110	5.80	5.96	5.50				

One liter aqueous 1 normal solution of the sodium salt of *o* cresol dissolves 7.57 gms. *o* cresol at 25°, 8.32 gms. at 40°, 9.84 gms. at 60° and 13.62 gms. at 80° (Sidgwick, 1910.)

## MISCIBILITY OF AQUEOUS ALKALINE SOLUTIONS OF *m* CRESOL WITH SEVERAL ORGANIC COMPOUNDS INSOLUBLE IN WATER. (Sheuble, 1907.)

To 5 cc. portions of aq. KOH solution (250 gms. per liter) were added the given amounts of the aq. insoluble compound from a buret, and then the *m* cresol dropwise, until solution occurred. Temp. not stated.

Composition of Homogeneous Solution.

cc. Aq. KOH.	Aq. Insol. Cmpd.		<i>m</i> Cresol.
5	2 cc. (1.64 gms.)	Octyl Alcohol*	1.1 gms.
5	5 " (4.1 " )	" "	1.8 "
5	2 " (1.74 " )	Toluene	4.4 "
5	3 " (2.61 " )	" "	5.1 "
5	2 " (1.36 " )	Heptane	6.4 "

\* = the normal secondary alcohol, the so-called capryl alcohol,  $\text{CH}_3(\text{CH}_2)_6\text{CH}(\text{OH})\text{CH}_3$ .



## DISTRIBUTION OF CRESOL BETWEEN WATER AND ETHER. (Vaubel, 1903.)

Composition of Solvent.	Gms. Cresol in H <sub>2</sub> O Layer.	In Ether Layer.
200 cc. H <sub>2</sub> O + 100 cc. Ether	0.0570	1.0760
200 cc. H <sub>2</sub> O + 200 cc. Ether	0.0190	1.1144

FREEZING-POINT LOWERING DATA (Solubility, see footnote, p. 1) FOR MIXTURES OF *o*, *m* AND *p* CRESOL (each determined separately) AND OTHER COMPOUNDS.

Mixture.	Authority.
<i>o</i> , <i>m</i> and <i>p</i> Cresol + Dimethylpyrone	(Kendall, 1914.)
" " + Picric Acid	(Kendall, 1916.)
" " + Pyridine	(Hatcher and Skirrow, 1917.)
<i>o</i> and <i>p</i> " + "	(Bramley, 1916.)
" " + Sulfuric Acid	(Kendall and Carpenter, 1914.)
<i>o</i> , <i>m</i> and <i>p</i> " + Urea	(Kreman, 1907.)
Trinitrocresol + Naphthalene	(Saposhnikow and Gelvich, 1903, 1904.)

CROTONIC ACIDS  $\alpha = \text{CH}_3\text{CH}:\text{CHCOOH}$ ,  $\beta = \text{HCH}_2\text{C}:\text{CHCOOH}$ .

## FREEZING-POINT LOWERING DATA FOR MIXTURES OF CROTONIC ACIDS AND OF CROTONIC ACID AND OTHER COMPOUNDS.

Mixture.	Authority.
$\alpha$ Crotonic Acid + $\beta$ Crotonic Acid	(Morrell and Hanson, 1904.)
" " + Dimethylpyrone	(Kendall, 1914.)
" " + Sulfuric Acid	(Kendall and Carpenter, 1914.)
Chlorocrotonic Acid + Dimethylpyrone	(Kendall, 1914.)
" " + Sulfuric Acid	(Kendall and Carpenter, 1914.)

Methyl CRYPTOPINES, *A*, *B* and *C* forms, C<sub>22</sub>H<sub>23</sub>O<sub>3</sub>N.

The solubilities of the three forms in benzene, determined by lowering of the freezing-point, are: 5 gms. *A* form per liter at 5°, 30 gms. *B* form and 110 gms. *C* form. (Sidgwick, 1915.)

CUMINIC ACID C<sub>9</sub>H<sub>7</sub>C<sub>4</sub>H<sub>9</sub>COOH (*p* Isopropyl Benzoic Acid).

SOLUBILITY IN WATER AT 25°. (Paul, 1894.)

1000 cc. sat. solution contain 0.1519 gm. or 0.926 millimol cuminic acid.

PseudoCUMIDINE (CH<sub>3</sub>)<sub>2</sub>C<sub>6</sub>H<sub>3</sub>NH<sub>2</sub> (*s*, 5 Amino, 1. 2. 4. Trimethyl Benzene).

SOLUBILITY IN WATER.

(Lowenherz, 1898.)

Gms. $\psi$ Cumidine per liter H <sub>2</sub> O	19.4°	23.7°	28.7°
	1.198	1.330	1.498

CYANAMIDE CN.NH<sub>2</sub>.

SOLUBILITY IN WATER, DETERMINED BY FREEZING-POINT METHOD.

(Pratolongo, 1913.)

° of Congealing.	Gms. CN.NH <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	° of Congealing.	Gms. CN.NH <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.
- 0.62	2.58	Ice	- 14.39	40.19	CN.NH <sub>2</sub>
- 3.96	9.42	"	- 2.49	56.80	"
- 7.58	18.40	"	+ 14.50	77.20	"
- 12.72	30.9	"	25.6	87.15	"
- 16.6 Eutec.	37.8	" + CN.NH <sub>2</sub>	37.90	96.77	"
- 15.6	38.75	CN.NH <sub>2</sub>	42.9	100	"

Similar data for CN.NH<sub>2</sub> + urea and  $\frac{1}{2}$ CN.NH<sub>2</sub> + dicyandiamide are also given.

DiCYANDIAMIDINE Perchlorate C<sub>2</sub>H<sub>4</sub>N<sub>4</sub>OHClO<sub>4</sub>.

100 gms. H<sub>2</sub>O dissolve 9.97 gms. of the salt at 17° (*d* sat. sol. = 1.039). (Carlson, 1910.)



CYANOGEN (CN)<sub>2</sub>.

## SOLUBILITY IN WATER AND OTHER SOLVENTS.

(Berthelot, 1904.)

The determinations were made over mercury with exclusion of air. The mercury was not attacked by the (CN)<sub>2</sub>. On account of polymerization, the solubility increased with time of contact and amount of agitation of the mixture.

One volume of H<sub>2</sub>O at 30° dissolves 3.5 vols. (CN)<sub>2</sub> after 2 hours, and 9.7 vols. after 97 hours.

One volume of abs. alcohol at 20° dissolves 26 vols. (CN)<sub>2</sub> immediately; 39 vols. after 4 hours; 89 vols. after 48 hrs. and 223 vols. after 4 days.

One volume glacial acetic acid dissolves 42 vols. of (CN)<sub>2</sub> immediately and 50.5 vols. after 3 days.

One volume of chloroform dissolves about 19 vols. (CN)<sub>2</sub> immediately and 29-30 vols. with time.

One volume of benzine finally dissolves 28 vols. (CN)<sub>2</sub>.

One volume of rectified turpentine dissolves 9-10 vols. of (CN)<sub>2</sub>.

One volume of ether dissolves 5 vols. (CN)<sub>2</sub> at 20°.

(Gay Lussc.)

CYCLOHEXANE (Hexamethylene, Hexahydrobenzene) CH<sub>2</sub> < (CH<sub>2</sub>.CH<sub>2</sub>)<sub>6</sub> > CH<sub>2</sub>.

Freezing-point data (solubility, see footnote, p. 1) for mixtures of cyclohexane and ethylene bromide are given by Baud (1913b). Results for mixtures of cyclohexane and methyl alcohol are given by Lecat (1909). Results for mixtures of cyclohexane and piperidine are given by Mascarelli and Constantino (1909, 1910).

CYCLOHEXANOL (CH<sub>2</sub>)<sub>6</sub>.CHOH.

100 gms. H<sub>2</sub>O dissolve 5.67 gms. cyclohexanol at 11°.

(de Forcrand, 1912.)

100 gms. cyclohexanol dissolve 11.27 gms. H<sub>2</sub>O at 11°.

"

## RECIPROCAL SOLUBILITY OF CYCLOHEXANOL AND WATER, DETERMINED BY THE FREEZING-POINT METHOD.

(de Forcrand, 1912.)

° of Solidification.	Gm. (CH <sub>2</sub> ) <sub>6</sub> .CHOH per 100 Gms. Mixture.	° of Solidification.	Gm. (CH <sub>2</sub> ) <sub>6</sub> .CHOH per 100 Gms. Mixture.
+22.45	100	-57.4 Eutec.	95.030
17.48	99.767	-43.2	93.150
-1.40	98.817	-33	91.962
-34.10	96.868	-18.50	90.980
-46.80	95.910	-14.58	90.36
-55.70	95.170	-12.05	88.73

Freezing-point data for mixtures of cyclohexanol and phenol are given by Mascarelli and Pestalozza, 1908, 1909,

CYCLOHEXANONE (CH<sub>2</sub>)<sub>6</sub>:CO.

Freezing-point data for mixtures of cyclohexanone and phenol are given by Schmidlin and Lang, 1910.

CYTISINE (Ulexine) C<sub>11</sub>H<sub>16</sub>N<sub>2</sub>O (m. pt. 151°-151.5°).

## SOLUBILITY IN SEVERAL SOLVENTS AT 15°.

(Van de Moer, 1891.)

Solvent.	Gms. C <sub>11</sub> H <sub>16</sub> N <sub>2</sub> O per 100 Gms. Sat. Sol.	Solvent.	Gms. C <sub>11</sub> H <sub>16</sub> N <sub>2</sub> O per 100 Gms. Sat. Sol.
Water	soluble in all proportions	Benzine	1.26
Alcohol	" " "	Petroleum Ether	insol.
Chloroform	" " "	Amyl Alcohol	0.303
Ether (d 0.725)	0.302	Carbon Disulfide	insol.
Ether, abs.	insol.	Ethyl Acetate	very soluble



**DEXTRIN**  $C_{12}H_{22}O_{10}$ .

## SOLUBILITY IN WATER. (Lewis, 1914.)

"In the case of dextrin, however, no matter how small an amount of water be employed, under no condition does the concentration of the solution remain constant, while on the other hand the addition of further solvent, never fails to dissolve additional dextrin, although the use of no amount of water, however large, will dissolve the whole of the sample."

100 gms. pyridine dissolve 65.44 gms. dextrin at 20–25°. (Dehn, 1917.)  
100 gms. aq. 50% pyridine dissolve 102 gms. dextrin at 20–25°. "

**DIACETYL TARTARIC ETHER** (m. pt. 104°) **DIACETYL RACEMIC ETHER** (m. pt. 84°).

Freezing-point lowering data for each of these compounds in ethylene bromide and in *p* xylene are given by Bruni and Finzi, 1905.

**DIBENZYL**  $C_6H_5CH_2CH_2C_6H_5$ .

Freezing-point lowering data for mixtures of dibenzyl and stilbene are given by Girelli and Calzolari, 1899.

**DIIDYMIUM AMMONIUM NITRATE**  $Di(NO_3)_2 \cdot 2NH_4NO_3$ .

100 gms.  $H_2O$  dissolve 292 gms. of the salt at 15°. (Holmberg, 1907.)

**DIIDYMIUM SULFATE**  $Di_2(SO_4)_3$ .

## SOLUBILITY IN WATER. (Marignac, 1853.)

t°.	Gms. $Di_2(SO_4)_3$ per 100 Gms. $H_2O$ .	Solid Phase.	t°.	Gms. $Di_2(SO_4)_3$ per 100 Gms. $H_2O$ .	Solid Phase.
12	43.1	$Di_2(SO_4)_3$	?	34.0	$Di_2(SO_4)_3 \cdot 6H_2O$
18	25.8	"	19	11.7	$Di_2(SO_4)_3 \cdot 8H_2O$
25	20.6	"	40	8.8	"
38	13	"	50	6.5	"
50	11	"	100	1.8	"

**DIDYMIUM POTASSIUM SULFATE**  $K_2SO_4 \cdot Di_2(SO_4)_3 \cdot 2H_2O$ . (Marignac.)

100 gms.  $H_2O$  dissolve 1.6 grams of the double salt at 18°.

**DIIDYMIUM SULFONATES.**

## SOLUBILITY IN WATER. (Holmberg, 1907.)

Salt.	Formula.	t°.	Gms. Anhydrous Salt per 100 Gms. $H_2O$ .
Didymium Benzene Sulfonate	$Di(C_6H_5SO_3)_2 \cdot 9H_2O$	15	53.1
" " Nitro Benzene Sulfonate	$Di(C_6H_4(NO_2)SO_3)_2 \cdot 6H_2O$	15	47.8
" " Chloro " "	$Di(C_6H_4ClSO_3)_2 \cdot 9H_2O$	15	12.7
" " Bromo " "	$Di(C_6H_4BrSO_3)_2 \cdot 9H_2O$	15	14.3
" " Chloro Nitro " "	$Di(C_6H_4Cl(NO_2)SO_3)_2 \cdot 16H_2O$	15	25.3
" " $\alpha$ Naphthalene Sulfonate	$Di(C_{10}H_7SO_3)_2 \cdot 6H_2O$	15	6.1
" " 1.5 Nitro " "	$Di(C_{10}H_6(NO_2)SO_3)_2 \cdot 6H_2O$	15	0.52
" " 1.6 " "	$Di(C_{10}H_6(NO_2)SO_3)_2 \cdot 9H_2O$	15	0.18
" " 1.7 " "	$Di(C_{10}H_6(NO_2)SO_3)_2 \cdot 9H_2O$	15	1.3

\* ( $SO_3:NO_2:Cl = 1:3:6$ ).

**DIETHYLAMINE** see **ETHYLAMINE**, page 294.**ECONINE** (Ethyl Morphine)  $C_{19}H_{23}NO_3$ .

100 cc.  $H_2O$  dissolve 0.2613 gm.  $C_{19}H_{23}NO_3$  at 20°. (Zalai, 1910.)  
100 cc. oil of sesame dissolve 0.5144 gm.  $C_{19}H_{23}NO_3$  at 20°. "



## DIPHENYL

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### DIPHENYL $C_6H_5.C_6H_5$ .

100 grams absolute methyl alcohol dissolve 6.57 grams at  $19.5^\circ$ .

100 grams abs. ethyl alcohol dissolve 9.98 grams at  $19.5^\circ$ . (de Bruyn, 1892.)

Freezing-point data (Solubility, see footnote, p. 1) are given for mixtures of diphenyl + naphthalene by Washburn and Read (1915) and by Vignon (1891). Results for diphenyl + phenanthrene and for diphenyl + triphenylmethane are given by Vignon (1891).

### DIPHENYLAMINE $(C_6H_5)_2NH$ .

#### RECIPROCAL SOLUBILITY OF DIPHENYLAMINE AND WATER, BY SYNTHETIC METHOD.

(Campetti and del Grosso, 1913.)

$t^\circ$ .	Gms. $(C_6H_5)_2NH$ per 100 Gms. Mixture.	$t^\circ$ .	Gms. $(C_6H_5)_2NH$ per 100 Gms. Mixture.	$t^\circ$ .	Gms. $(C_6H_5)_2NH$ per 100 Gms. Mixture.
231	1.48	305 crit. t.	47.5	239	88.28
264	3.49	304	62.52	229	90.23
275	5.62	299	73.07	210	92.93
297	16.50	289	82.08	152	97.19
303	45.16	249	86.73		

Similar data for the systems diphenylamine + ether and diphenylamine + isopentane are given by Campetti, 1917.

#### SOLUBILITY OF DIPHENYLAMINE IN SEVERAL SOLVENTS.

Solvent.	$t^\circ$ .	Gms. $(C_6H_5)_2NH$ per 100 Gms. Solvent.	Authority.
Water	20-25	0.03	(Dehn, 1917.)
Methyl Alcohol	14.5	45.2	(Timofeiew, 1894.)
" "	19.5	57.5	(de Bruyn, 1892.)
Ethyl Alcohol	14.5	39.4	(Timofeiew, 1894.)
" "	19.5	56	(de Bruyn, 1892.)
Propyl Alcohol	14.5	29.4	(Timofeiew, 1894.)
Pyridine	20-25	302	(Dehn, 1917.)
Aq. 50% Pyridine	20-25	two layers formed	"

#### SOLUBILITY OF DIPHENYLAMINE AND ALSO OF TRIPHENYLAMINE IN CARBON DISULFIDE. (Arctowski, 1895.)

$NH(C_6H_5)_2$ in $CS_2$		$N(C_6H_5)_3$ in $CS_2$	
$t^\circ$ .	Gms. per 100 Gms. Solution.	$t^\circ$ .	Gms. per 100 Gms. Solution.
-88½	0.87	-83	1.91
-117	0.37	-91	1.56
		-102	1.24
		-113½	0.98

#### SOLUBILITY OF DIPHENYLAMINE IN HEXANE AND IN CARBON DISULFIDE. (Etard, 1894.)

$Gms. NH(C_6H_5)_2$ per 100 Gms. Sol. in:			$Gms. NH(C_6H_5)_2$ per 100 Gms. Sol. in:		
$t^\circ$ .	Hexane.	$CS_2$ .	$t^\circ$ .	Hexane.	$CS_2$ .
-60	...	1.3	0	2.6	33.7
-50	...	2.2	+10	3.8	46.8
-40	...	3.8	20	6.7	60.9
-30	0.5	7.2	30	13.8	76
-20	0.8	12.5	40	47	...
-10	1.4	21.6	50	94	...



## FREEZING-POINT DATA FOR MIXTURES OF DIPHENYLAMINE AND OTHER COMPOUNDS.

Diphenylamine	+ Acetyldiphenylamine	(Böeseken, 1912.)
"	+ Ethylene Bromide	(Dahms, 1895.)
"	+ Naphthalene	(Roloß, 1895; Vignon, 1891.)
"	+ $\alpha$ Naphthylamine	(Vignon, 1891.)
"	+ Nitronaphthalene	(Battelli and Martinetti, 1885.)
"	+ $\alpha$ and $\beta$ Naphthol	(Vignon, 1891.)
"	+ Paraffin	(Palazzo and Battelli, 1883.)
"	+ Phenanthrene	(Narbutt, 1905.)
"	+ Phenol	(Philip, 1901.)
"	+ Resorcinol	(Vignon, 1891.)
"	+ $p$ Nitrotoluene	(Giua, 1915.)
"	+ 2,4 Dinitrotoluene	"
"	+ $\alpha$ Trinitrotoluene	"
"	+ $p$ Toluidine	(Vignon, 1891.)
"	+ Urethan	(Pushin and Grebenschikov, 1913.)
Diphenylmethylamine	+ Phenol	(Bramley, 1916.)
"	+ $o$ Chlorophenol	"
Hexanitrodiphenylamine	+ $\alpha$ Trinitrotoluene	(Giua, 1915.)

## DIPHENYLAMINE BLUE.

## SOLUBILITY IN SEVERAL SOLVENTS AT 23°.

(Szathmáry de Szachinar, 1910.)

Solvent.	Gms. Diphenylamine Blue per 100 Gms. Sat. Sol.	Solvent.	Gms. Diphenylamine Blue per 100 Gms. Sat. Sol.
Methyl Alcohol	0.385	Acetone	0.177
Ethyl "	0.230	Aniline	0.395
Amyl "	0.049		

DIPHENYL SULFIDE  $(C_6H_5)_2S$ , etc.

Freezing-point lowering data for mixtures of  $(C_6H_5)_2S$  +  $(C_6H_5)_2Se$ ,  $(C_6H_5)_2S$  +  $(C_6H_5)_2Te$ ,  $(C_6H_5)_2S$  +  $(C_6H_5)_2O$ ,  $(C_6H_5)_2Se$  +  $(C_6H_5)_2Te$ , are given by Pascal (1912).

## DYES.

Data for the distribution of 12 dyes between water and isobutyl alcohol at 25°, are given by Reinders and Lely, Jr. (1912).

DYSPROSIUM OXALATE  $Dy_2(C_2O_4)_3 \cdot 10H_2O$ .

100 cc. aq. 20% methylamine oxalate dissolve	0.276 gm.	$Dy_2(C_2O_4)_3$	} (Grant and James, 1917.)
" " ethylamine " "	1.787 " "	" "	
" " triethylamine " "	1.432 " "	" "	

## EDESTIN and Edestin Salts.

## SOLUBILITY IN AQ. SALT SOLUTIONS AT 25°.

(Osborne and Harris, 1905.)

The determinations were made by shaking an excess of the air-dry preparation with 20 cc. of the salt solution, allowing the globulin to settle and determining nitrogen in 10 cc. of the clear supernatant solution. The edestin or edestin salt was calculated from the N. The results are given in the form of curves. The following figures were read from the curve for the solubility of neutral edestin in aq. NaCl.

Gms. NaCl per 20 cc. Solvent	→ 0.468	0.585	0.702	0.818	0.935
Gm. Edestin per 20 cc. Sat. Sol.	→ 0.25	0.55	0.92	1.25	1.45

Curves are also given for the solubility of edestin in aqueous solutions of many other salts and of the solubility of edestin chloride, bichloride and sulfate in aq. sodium chloride solutions.

100 gms. pyridine dissolve	0.07 gm. edestin at 20-25°.	(Dehn, 1917.)
100 gms. aq. 50% pyridine dissolve	9.05 gm. edestin at 20-25°.	"



**ELATERIN**

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**ELATERIN**  $C_{20}H_{28}O_4$ .

100 cc. 90% alcohol dissolve 0.09 gm. elaterin at 15-20. (Squire and Caines, 1905.)  
 100 cc. chloroform dissolve 4 gms. elaterin at 15-20. " "

**EMETINE** and Salts.**SOLUBILITY IN WATER.**

(Carr and Pyman, 1914.)

Salt.	Formula.	t°.	Gms. Hydrated Salt per 100 cc. Sat. Sol.
Emetine Hydrochloride	$C_{29}H_{40}O_4N_2 \cdot 2HCl \cdot 7H_2O$	18	13.1
" Hydrobromide	$C_{29}H_{40}O_4N_2 \cdot 2HBr \cdot 4H_2O$	17-18	1.9
" Nitrate	$C_{29}H_{40}O_4N_2 \cdot 2HNO_3 \cdot 3H_2O$	17-18	3.7
" Sulfate	$C_{29}H_{40}O_4N_2 \cdot H_2SO_4 \cdot 7H_2O$	17-18	more than 100

**ERBIUM OXALATE**  $Er_2(C_2O_4)_3 \cdot 14H_2O$ .**SOLUBILITY IN AQ. SULFURIC ACID AT 25°.**

(Wirth, 1912.)

Normality of Aq. $H_2SO_4$ .	Gms. per 100 Gms. Sat. Sol. $Er_2O_3$ .	Gms. Sat. Sol. $Er_2(C_2O_4)_3$ .	Solid Phase.
2.16	0.329	0.5144	$Er_2(C_2O_4)_3 \cdot 14H_2O$
3.11	0.493	0.7708	"
4.32	0.7036	1.10	"
6.175	1.10	1.72	"

**ERBIUM** Dimethyl **PHOSPHATE**  $Er_2[(CH_3)_2PO_4]_3$ .

100 gms.  $H_2O$  dissolve 1.78 gm.  $Er_2[(CH_3)_2PO_4]_3$  at 25°. (Morgan and James, 1914.)

**ERBIUM SULFATE**  $Er_2(SO_4)_3 \cdot 8H_2O$ .**SOLUBILITY IN WATER AND AQ.  $H_2SO_4$  AT 25°.**

(Wirth, 1912.)

Normality of $H_2SO_4$ .	Gms. per 100 Gms. Sat. Sol. $Er_2O_3$ .	Gms. Sat. Sol. $Er_2(SO_4)_3$ .	Solid Phase.	Normality of $H_2SO_4$ .	Gms. per 100 Gms. Sat. Sol. $Er_2O_3$ .	Gms. Sat. Sol. $Er_2(SO_4)_3$ .	Solid Phase.
Water alone	7.339	11.94	$Er_2(SO_4)_3 \cdot 8H_2O$	2.16	3.98	6.473	$Er_2(SO_4)_3 \cdot 8H_2O$
0.1	7.389	12.02	"	6.175	0.9352	1.521	"
0.505	6.249	10.164	"	12.6	0.0852	0.1386	"
1.1	5.256	8.549	"				

**ERBIUM** Bromonitrobenzene **SULFONATE**  $Er(C_6H_4Br.NO_2.SO_3, 1.4.2)_3 \cdot 12H_2O$ .

100 gms. sat. solution in water contain 6.056 gms. anhydrous salt at 25°.

(Katz and James, 1913.)

**ERUCIC ACID**  $C_{21}H_{41}CH:CH(CH_2)_{11}COOH$ .**SOLUBILITY IN ALCOHOLS.**

(Timofeiew, 1894.)

Alcohol.	t°.	Gms. Erucic Acid per 100 Gms. Sat. Sol.	Alcohol.	t°.	Gms. Erucic Acid per 100 Gms. Sat. Sol.
Methyl Alcohol	- 2	2.25	Ethyl Alcohol	+ 21.4	63.4
" "	+ 18	60.4	Propyl Alcohol	- 2	10.2
" "	21.4	62	" "	+ 18	60.5
Ethyl Alcohol	- 2	8.24	" "	21.4	63

**ERYTHRITOL**  $(CH_2OH.CHOH)_2$ .

100 gms.  $H_2O$  dissolve 61.5 gms. erythritol at 20-25°.

(Deha, 1917)

100 gms. aq. 50% pyridine dissolve 8.47 gms. erythritol at 20-25°.

100 gms. pyridine dissolve 2.50 + gms. erythritol at 20-25°. (Deha, 1917; Hoky, 1905.)



**ETHANE  $C_2H_6$ .****SOLUBILITY IN WATER.**  
(Winkler, 1901.)

$t^\circ$ .	$\beta$ .	$\beta'$ .	$q$ .	$t^\circ$ .	$\beta$ .	$\beta'$ .	$q$ .
0	0.0987	0.0982	0.0132	40	0.0292	0.0271	0.0037
5	0.0803	0.0796	0.0107	50	0.0246	0.0216	0.0029
10	0.0656	0.0648	0.0087	60	0.0218	0.0175	0.0024
15	0.0550	0.0541	0.0073	70	0.0195	0.0135	0.0018
20	0.0472	0.0462	0.0062	80	0.0183	0.0097	0.0013
25	0.0410	0.0398	0.0054	90	0.0176	0.0054	0.0007
30	0.0362	0.0347	0.0049	100	0.0172	0.0000	0.0000

$\beta$  = Absorption coefficient, *i.e.*, the volume of gas (reduced to  $0^\circ$  and 760 mm.) absorbed by 1 volume of the liquid when the pressure of the gas itself without the tension of the liquid amounts to 760 mm.

$\beta'$  = Solubility, *i.e.*, the volume of gas (reduced to  $0^\circ$  and 760 mm.) which is absorbed by one volume of the liquid when the barometer indicates 760 mm. pressure.

$q$  = the weight of gas in grams which is taken up by 100 grams of the pure solvent at the indicated temperature and a total pressure (that is, the partial pressure of the gas plus the vapor pressure of the liquid at the absorption temperature) of 760 mm.

Freezing-point data for mixtures of ethane and hydrochloric acid are given by Baume and Georgitses, 1912, 1914.

**SOLUBILITY OF ETHANE IN SEVERAL ALCOHOLS AND OTHER SOLVENTS.**  
(McDaniel, 1911.)

Solvent.	$t^\circ$ .	Abs. Coef. A.	Bunsen Coef. B.	Solvent.	$t^\circ$ .	Abs. Coef. A.	Bunsen Coef. B.
Methyl Alcohol (99%)	22.1	0.4436	0.4102	Amyl Alcohol	22	0.4532	0.4196
"	30.2	0.4278	0.3883	"	30.1	0.4444	0.4002
"	40	0.3938	0.3436	Benzene	22.1	0.4954	0.4600
"	49.8	0.2695	0.2278	"	35	0.4484	0.3976
Ethyl Alcohol (99.8%)	22.2	0.4628	0.4282	"	40.1	0.4198	0.3661
"	30.2	0.4503	0.4051	"	49.9	0.3645	0.3081
"	40	0.4323	0.3771	Toluene	25	0.4852	0.4450
Isopropyl Alcohol	21.5	0.4620	0.4275	"	30	0.4778	0.4300
"	29.9	0.4532	0.4081	"	40.1	0.4675	0.4080
"	40	0.4400	0.3837	"	50.2	0.4545	0.4013
"	60.3	0.4244	0.3478	"	60	0.4502	0.3690

Abs. coef. A = vol. of ethane absorbed by unit volume of solvent at the temp. stated.

For definition of Bunsen Coef. B, see  $\beta$  above, and also carbon dioxide, p. 227.

Additional data for the solubility of ethane in amyl alcohol are given by (Friedel and Gorgeu, 1908).

**ETHYL ACETATE  $CH_3COOC_2H_5$ .****SOLUBILITY OF ETHYL ACETATE IN WATER AND VICE VERSA.**  
(Merriman, 1913, see also Seidell, 1910.)**Results for Ethyl Acetate in Water.**

$t^\circ$ .	$d_{40}^\circ$ of Sat. Sol.	Gms. $CH_3COOC_2H_5$ per 100 Gms. $H_2O$
0	1.0034	11.21
5	1.0022	10.38
10	1.0009	9.67
15	0.9995	9.05
20	0.9979	8.53
25	0.9962	8.08
30	0.9943	7.71
40	0.9901	7.10

**Results for Water in Ethyl Acetate.**

$t^\circ$ .	$d_{40}^\circ$ of Sat. Sol.	Gms. $H_2O$ per 100 Gms. $CH_3COOC_2H_5$ .
0	0.9280	2.34
10	0.9164	2.68
20	0.9054	3.07
25	0.9002	3.30
30	0.8953	3.52
40	0.8863	4.08
50	...	4.67
60	...	5.29



## SOLUBILITY IN WATER AND IN AQUEOUS SALT SOLUTIONS A

(Euler — Z. physik. Chem. 31, 365, '99; 49, 306, '04.)

Solvent.	Conc. of Salt Solution.		CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub> per Liter.		Solvent.	Conc. of Salt Solution.		CH <sub>3</sub>
	Nor-mality.	Gms. per Liter.	Gram Mols.	Grams.		Nor-mality.	Gms. per Liter.	
Water	0	0	0.825	75.02	NaCl (at 18°)	$\frac{1}{2}$	14.62	0.7
KNO <sub>3</sub>	$\frac{1}{2}$	50.59	0.77	67.81	"	$\frac{1}{2}$	29.25	0.6
"	1	101.19	0.72	63.40	"	1	58.5	0.5
"	2	202.38	0.625	55.04	Na <sub>2</sub> SO <sub>4</sub>	1	71.08	0.4
KCl	$\frac{1}{2}$	18.4	0.747	65.79	" (at 18°)	$\frac{1}{2}$	35.54	0.6
"	$\frac{1}{2}$	36.8	0.685	65.33	"	1	71.08	0.4
"	1	73.6	0.575	50.64	MgSO <sub>4</sub>	$\frac{1}{2}$	16.30	0.7
"	2	147.2	0.41	36.11	"	$\frac{1}{2}$	32.6	0.6
NaCl	$\frac{1}{2}$	14.62	0.745	65.61	"	1	65.21	0.5
"	$\frac{1}{2}$	29.25	0.677	59.62	ZnSO <sub>4</sub>	$\frac{1}{2}$	20.18	0.7
"	1	58.5	0.545	47.99	"	$\frac{1}{2}$	40.36	0.6
"	2	117.0	0.315	27.74	"	1	80.73	0.5

Additional data for the influence of salts upon the solubility of ethyl water are given by Lundin, 1913.

## SOLUBILITY OF ETHYL ACETATE IN AQUEOUS SOLUTIONS OF ETHYL ALCOH (Seidell, 1910.)

Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	d <sub>m</sub> of Sat. Sol.	cc. CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub> per 100 cc. Solvent.	Gms. CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub> per 100 Gms. Solvent.
0	0.999	10	8.6
5	0.993	10.5	9.5
10	0.986	12	10.9
15	0.974	15	13.3
20	0.960	27	19.6
25	0.945	44	37.0
30	0.931	70	66.7
35	0.918	125	132.5
40	...	∞	∞

## SOLUBILITY OF ETHYL ACETATE IN AQUEOUS ETHYL ALCOHOL, ALCOHOL, AND ACETONE MIXTURES AT 20°.

(Bancroft — Phys. Rev. 3, 122, 131, '95-'96.)

In Ethyl Alcohol.		In Methyl Alcohol.		In Ace	
Per 1 cc. C <sub>2</sub> H <sub>5</sub> OH.		Per 1 cc. CH <sub>3</sub> OH.		Per 1 cc. (C	
cc. H <sub>2</sub> O.*	cc. CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub> .†	cc. H <sub>2</sub> O.	cc. CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub> .	cc. H <sub>2</sub> O.	CH <sub>3</sub>
10	0.25	10	1.08	10	
8	0.27	3	0.68	5	
4	0.35	1.5	1.69	2	
2	1.02	1.29	2.50	1.5	
1.06	2.50	1.0	4.9	1.0	
0.65	5.0	0.98	7.0	0.8	
0.54	7.0	1.0	8.0	0.51	
0.44	10.0	1.03	10.0	0.25	
				0.29	

\* Saturated with ethyl acetate.

† Saturated with water.

Data for the distribution of ethyl acetate between petroleum and w zene and water, and benzene and a large number of aqueous solutions, temperatures, are given by Philip and Bramley, 1915.



RECIPROCAL SOLUBILITY OF ETHYL ALCOHOL AND WATER AT LOW TEMPERATURES, DETERMINED BY THE FREEZING-POINT METHOD.  
(Pictet and Altschul, 1895; Pickering, 1893.)

°. of Fusng.	Sp. Gr. Sat. Sol.	Gms. C <sub>2</sub> H <sub>5</sub> OH per Solid 100 Gms. Sat. Sol.		°. of Freezing.	Sp. Gr. Sat. Sol.	Gms. C <sub>2</sub> H <sub>5</sub> OH per 100 Gms. Sat. Sol.		Solid Phase.
- 1	0.9962	2.5	Ice	- 23.6	0.9512	33.8	Ice	
- 2	0.9916	4.8	"	- 28.7	0.9417	39	"	
- 3	0.9870	6.8	"	- 33.9	0.9270	46.3	"	
- 5	0.9824	11.3	"	- 41	0.9047	56.1	"	
- 6.1	0.9793	13.8	"	- 50	...	68	"	
- 8.7	0.9747	17.5	"	- 60	...	75	"	
- 9.4	0.9732	18.8	"	- 70	...	80	"	
-10.6	0.9712	20.3	"	- 80	...	83.5	"	
-12.2	0.9689	22.1	"	-100	...	89.5	"	
-14	0.9662	24.2	"	-118 Eutec.	...	93.5	" + C <sub>2</sub> H <sub>5</sub> OH	
-16	0.9627	26.7	"	-115	...	96	C <sub>2</sub> H <sub>5</sub> OH	
-18.9	0.9578	29.9	"	-110.5	...	100	"	

The result for the eutectic and for the f.-pt. of C<sub>2</sub>H<sub>5</sub>OH are by Puschin and Glogoleva, 1914, 1915; the other data for concentrations of C<sub>2</sub>H<sub>5</sub>OH above 70% were obtained by extrapolation. Additional data for the freezing-point lowering are given by Rozsa (1911).

Freezing-point lowering data for mixtures of ethyl alcohol and hydrochloric acid are given by Maass and McIntosh, 1913.

The distribution coefficient of ethyl alcohol between amylalcohol and water was found by Fontein (1910) to be 1.13 at 15.5° and 1.21 at 28°.

MISCIBILITY OF ETHYL ALCOHOL WITH MIXTURES OF:

Benzaldehyde and Water at 0°.

(Bonner, 1910.)

Composition of Homogeneous Mixtures.

Gms. C <sub>6</sub> H <sub>5</sub> CHO.	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. of Mixture.
0.957	0.043	0.159	1.02
0.898	0.102	0.283	1.01
0.800	0.200	0.420	0.99
0.700	0.300	0.550	0.98
0.598	0.402	0.601	0.97
0.570	0.430	0.610	...
0.496	0.504	0.643	0.96
0.394	0.606	0.681	0.95
0.298	0.702	0.701	0.95
0.200	0.800	0.670	0.95
0.100	0.900	0.610	0.96
0.031	0.969	0.461	0.97

Benzene and Water at 15°.

(Bonner, 1910.) (See also, p. 125.)

Composition of Homogeneous Mixtures.

Gms. C <sub>6</sub> H <sub>6</sub> .	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. of Mixture.
0.987	0.013	0.170	0.86
0.937	0.063	0.356	0.87
*0.900	0.100	0.500	0.86
0.800	0.200	0.860	0.86
0.700	0.300	0.910	0.88
0.600	0.400	1.07	0.87
0.500	0.500	1.18	0.87
0.400	0.600	1.22	0.88
0.300	0.700	1.21	0.89
0.201	0.799	1.13	0.89
0.100	0.900	0.97	0.92
0.020	0.980	0.59	0.94

NOTE. — The determinations were made by gradually adding ethyl alcohol to the mixtures of the given amounts of water and the other constituent until a homogeneous solution was obtained. The results give the binodal curve for the system. The author also determined "tie lines" showing the compositions of various pairs of liquids which may exist in equilibrium. As the two layers approach each other in composition, the tie line is gradually shortened and finally reduced to a point, designated as the "plait point" of the binodal curve. This point is indicated by a \* in the above tables. The mixtures above and below the correspond, according to their Sp. Gr., to the upper and lower layers of the system. See also, last table p. 289.

The distribution coefficient of ethyl alcohol between benzene and water at 25° was found by Morgan and Benson (1907) to be 1.16. Additional data for this system are also given by Bubonovic, 1913 and by Taylor (1897).



MISCIBILITY OF ETHYL ALCOHOL (see Note, p. 287) WITH MIXTURES OF:  
Bromobenzene and Water at 0°. Nitrobenzene and Water at 15°.  
(Bonner, 1910.) (Bonner, 1910.)

## Composition of Homogeneous Mixtures.

Gms. $C_6H_5Br$ .	Gms. $H_2O$ .	Gms. $C_2H_5OH$ .	Sp. Gr. Sat. Sol.
0.99	0.010	0.115	1.34
*0.96	0.040	0.32	...
0.90	0.10	0.65	1.07
0.80	0.20	1	0.96
0.70	0.30	1.19	0.96
0.60	0.40	1.30	0.98
0.50	0.50	1.39	0.95
0.40	0.60	1.43	0.91
0.30	0.70	1.43	0.92
0.20	0.80	1.36	0.93
0.10	0.90	1.16	0.93
0.024	0.976	0.803	0.92

## Composition of Homogeneous Mixtures.

Gms. $C_6H_5NO_2$ .	Gms. $H_2O$ .	Gms. $C_2H_5OH$ .	Sp. Gr. Sat. Sol.
0.965	0.035	0.248	1.08
*0.91	0.09	0.49	...
0.90	0.10	0.53	1.02
0.80	0.20	0.86	0.97
0.70	0.30	1.09	0.94
0.594	0.406	1.238	0.93
0.50	0.50	1.31	0.92
0.40	0.60	1.34	0.92
0.30	0.70	1.30	0.91
0.194	0.806	1.212	0.92
0.10	0.90	0.98	0.93
0.02	0.98	0.601	0.95

MISCIBILITY OF ETHYL ALCOHOL (see Note, p. 287) AT 0° WITH MIXTURES OF:  
Benzyl Acetate and Water. (Bonner, 1910.) Benzyl Alcohol and Water. (Bonner, 1910.)

## Composition of Homogeneous Mixtures.

Gms. $CH_3CO_2CH_2C_6H_5$ .	Gms. $H_2O$ .	Gms. $C_2H_5OH$ .	Sp. Gr. Sat. Sol.
0.977	0.023	0.120	1.05
0.901	0.099	0.317	1.03
0.80	0.200	0.46	0.99
0.70	0.300	0.58	0.97
*0.68	0.32	0.60	...
0.60	0.40	0.69	0.95
0.50	0.50	0.78	0.94
0.40	0.60	0.85	0.94
0.30	0.70	0.88	0.93
0.20	0.80	0.88	0.93
0.10	0.90	0.80	0.94
0.041	0.959	0.665	0.95

## Composition of Homogeneous Mixtures.

Gms. $C_6H_5CH_2OH$ .	Gms. $H_2O$ .	Gms. $C_2H_5OH$ .	Sp. Gr. Sat. Sol.
0.90	0.10	0.13	1.03
0.80	0.20	0.26	1
0.70	0.30	0.35	0.98
0.60	0.40	0.39	0.98
0.50	0.50	0.40	0.97
0.40	0.60	0.41	0.97
*0.38	0.62	0.42	...
0.379	0.621	0.417	0.98
0.30	0.70	0.41	0.97
0.194	0.806	0.388	0.97
0.10	0.90	0.35	0.98
0.04	0.96	0.139	0.99

MISCIBILITY OF ETHYL ALCOHOL (see Note, p. 287) AT 0° WITH MIXTURES OF:  
Benzylethyl Ether and Water. Carbon Tetrachloride and Water.  
(Bonner, 1910.) (Bonner, 1910.)

## Composition of Homogeneous Mixtures.

Gms. $C_6H_5CH_2OC_2H_5$ .	Gms. $H_2O$ .	Gms. $C_2H_5OH$ .	Sp. Gr. Sat. Sol.
0.971	0.029	0.189	0.94
0.90	0.10	0.37	0.92
0.80	0.20	0.54	0.92
0.70	0.30	0.67	0.91
*0.67	0.33	0.71	...
0.60	0.40	0.78	0.91
0.50	0.50	0.87	0.91
0.40	0.60	0.93	0.92
0.30	0.70	0.96	0.92
0.198	0.802	0.952	0.92
0.10	0.90	0.86	0.93
0.08	0.92	0.793	0.94

## Composition of Homogeneous Mixtures.

Gms. $CCl_4$ .	Gms. $H_2O$ .	Gms. $C_2H_5OH$ .	Sp. Gr. Sat. Sol.
0.961	0.039	0.224	1.36
0.928	0.072	0.347	1.23
*0.92	0.08	0.39	...
0.90	0.10	0.45	1.20
0.80	0.20	0.67	1.15
0.70	0.30	0.82	1.07
0.60	0.40	0.94	1.03
0.499	0.501	1.04	1
0.40	0.60	1	0.97
0.25	0.75	1.105	0.95
0.10	0.90	1	0.92
0.032	0.968	0.745	0.93



## DISTRIBUTION OF ETHYL ALCOHOL AT 25° (Bugarszky, 1910) BETWEEN:

Bromobenzene and Water.		Carbon Tetrachloride and Water.		Carbon Disulfide and Water.	
Gms. C <sub>2</sub> H <sub>5</sub> OH per Liter.		Gms. C <sub>2</sub> H <sub>5</sub> OH per Liter.		Gms. C <sub>2</sub> H <sub>5</sub> OH per Liter.	
C <sub>6</sub> H <sub>5</sub> Br Layer.	H <sub>2</sub> O Layer.	CCl <sub>4</sub> Layer.	H <sub>2</sub> O Layer.	CS <sub>2</sub> Layer.	H <sub>2</sub> O Layer.
0.72	18.5	0.45	18.7	0.27	19.1
1.36	36.9	0.93	36.5	1.87	37.
2.68	68.2	2.55	68.1	10.23	69.3

## MISCIBILITY OF ETHYL ALCOHOL (see Note p. 287) AT 0° WITH MIXTURES OF:

## Chloroform and Water. (Bonner, 1910.)

## Composition of Homogeneous Mixtures.

Gms. CHCl <sub>3</sub> .	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. Sat. Sol.
0.907	0.093	0.434	1.19
0.90	0.10	0.45	1.18
0.80	0.20	0.60	1.12
0.70	0.30	0.68	1.07
0.593	0.407	0.726	1.04
0.501	0.499	0.729	1.03
*0.420	0.58	0.73	...
0.404	0.596	0.733	1.01
0.300	0.70	0.70	0.99
0.197	0.803	0.672	0.98
0.100	0.90	0.61	0.98
0.088	0.912	0.608	0.98

## Diethylketone and Water. (Bonner, 1910.)

## Composition of Homogeneous Mixtures.

Gms. C <sub>2</sub> H <sub>5</sub> CO.C <sub>2</sub> H <sub>5</sub> .	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. Sat. Sol.
0.938	0.062	0.136	0.85
0.900	0.10	0.19	0.85
0.895	0.105	0.201	0.86
0.800	0.20	0.31	0.87
0.781	0.219	0.317	0.87
0.702	0.298	0.356	0.88
0.600	0.400	0.392	0.80
0.547	0.453	0.410	0.90
0.499	0.501	0.411	0.91
0.458	0.542	0.415	0.92
0.407	0.593	0.404	0.91

Additional data for the miscibility of alcohol with chloroform + water mixtures are given by Miller and McPherson, 1908.

## MISCIBILITY OF ETHYL ALCOHOL WITH MIXTURES OF ETHYL ETHER AND WATER AT 0°. (Corliss, 1914; Bonner, 1910; see also Kremann, 1910a.)

## Composition of the Lower Layer.

Gms. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. Sat. Sol.
0.10	0.90	0.163	0.970
...	...	...	...
0.16	0.84	0.207	0.951
0.178	0.822	0.318	0.945
0.192	0.808	0.332	0.941
0.204	0.796	0.34	0.937
0.227	0.773	0.352	0.932
0.250	0.75	0.36	0.926
0.293	0.707	0.37	0.916
0.335	0.665	0.375	0.906
0.422	0.578	0.385	0.886
*0.49	0.51	0.385	0.874

## Composition of Upper Layer.

Gms. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. Sat. Sol.
...	...	...	...
0.957	0.043	0.151	0.757
0.902	0.098	0.230	0.778
0.87	0.13	0.26	0.788
0.85	0.15	0.275	0.794
0.825	0.175	0.292	0.800
0.79	0.210	0.313	0.808
0.759	0.243	0.33	0.815
0.70	0.30	0.35	0.827
0.645	0.355	0.366	0.839
0.562	0.438	0.385	0.857
0.49	0.51	0.385	0.874

The data for the binodal curve given by Corliss and by Bonner agree closely. The Sp. Gr. determinations of Corliss were made on larger amounts of solution and appear to be the more accurate. In addition, Corliss gives the specific gravities of each layer of a series of liquids in contact with each other, and from these and the binodal curve, the above data for the composition of the several conjugate layers have been calculated. Data are also given by Corliss for the distribution of colloidal arsenious sulfide between the two layers of the system.

Data for the distribution of ethyl alcohol between ether and water and between ether and molten CaCl<sub>2</sub>·6H<sub>2</sub>O are given by Morgan and Benson (1907).



**MISCIBILITY OF ETHYL ALCOHOL WITH MIXTURES OF ETHYL ETHER  
WATER AT 25°. (Horiba, 1911-12.)**

Composition of Lower Layer.			Composition of Upper Layer.		
Gms. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Gms. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	Gms. H <sub>2</sub> O.	G.
5.77	94.23	0	98.72	1.28	
6.3	85.7	8	94.5	2.2	
7.2	79.2	13.6	88.5	3.7	
8	76	16	84.4	4.9	1
9.7	70.4	19.9	75.1	8.4	1
13.3	62.8	23.9	60.8	15.5	2
22.1	50.6	27.3	43.8	28.1	2
28.4	43.4	28.2	35.8	35.6	2
*31.6	40	28.4 (Plait point)	31.6	40	2

The binodal curve was determined in the usual way (see Note, p. 287). A of conjugate liquids was then prepared and the Sp. Gr., refractive index and viscosity of each layer determined. From specially prepared curves for values of physical constants with composition of mixture, the composition of the conjugate liquids was ascertained. The results thus obtained, are given above table.

Data for the miscibility of ethyl alcohol with mixtures of water, ethyl ethyl sulfuric acid at 0° and with mixtures of ethyl ether, water and ethyl acid at 0° are given by Kremann, 1910a.

**MISCIBILITY OF ETHYL ALCOHOL (see Note p. 287) AT 0° WITH MIXTURES**

**Ethyl Acetate and Water. (Bonner, 1910.)**

Composition of Homogeneous Mixtures.

Gms. CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub> .	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. Sat. Sol.
0.02	0.080	0.100	0.91
0.10	0.10	0.13	0.91
0.799	0.201	0.228	0.93
0.699	0.301	0.265	0.92
0.60	0.40	0.29	0.95
0.50	0.50	0.30	0.95
*0.48	0.52	0.30	...
0.40	0.60	0.31	0.96
0.30	0.70	0.31	0.96
0.197	0.803	0.282	0.97
0.102	0.898	0.143	0.99

**Ethyl Bromide and Water. (Bonner, 1910.)**

Composition of Homogeneous Mixtures.

Gms. C <sub>2</sub> H <sub>5</sub> Br.	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.
0.967	0.033	0.240
0.90	0.10	0.37
*0.83	0.17	0.45
0.80	0.20	0.51
0.70	0.30	0.64
0.60	0.40	0.754
0.50	0.50	0.83
0.40	0.60	0.89
0.30	0.70	0.89
0.10	0.90	0.73
0.017	0.983	0.182

**MISCIBILITY OF ETHYL ALCOHOL (see Note p. 287) AT 0°, WITH MIXTURES**

**Ethyl Butyrate and Water. (Bonner, 1910.)**

Composition of Homogeneous Mixtures.

Gms. C <sub>3</sub> H <sub>7</sub> COOC <sub>2</sub> H <sub>5</sub> .	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. Sat. Sol.
0.97	0.030	0.166	0.96
0.90	0.10	0.32	...
0.80	0.20	0.483	0.88
0.70	0.30	0.567	0.89
0.599	0.401	0.628	0.90
0.494	0.506	0.659	0.91
*0.46	0.54	0.67	...
0.40	0.60	0.69	0.92
0.297	0.703	0.693	0.93
0.193	0.807	0.684	0.94
0.10	0.90	0.63	0.94

**Ethyl Propionate and Water. (Bonner, 1910.)**

Composition of Homogeneous Mixtures.

Gms. C <sub>3</sub> H <sub>7</sub> COOC <sub>2</sub> H <sub>5</sub> .	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.
0.977	0.023	0.138
0.90	0.10	0.27
0.80	0.20	0.38
0.695	0.305	0.453
0.60	0.40	0.49
0.50	0.50	0.52
*0.46	0.54	0.53
0.398	0.602	0.532
0.30	0.70	0.55
0.201	0.799	0.517
0.10	0.90	0.46



SOLUBILITY OF ETHYL ALCOHOL (see Note, p. 287) AT 0° WITH MIXTURES OF:  
Ethylene Chloride and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

wt. %	Gms. $\text{H}_2\text{Cl}_2$	Gms. $\text{C}_2\text{H}_5\text{OH}$	Sp. Gr. Sat. Sol.
71	0.029	0.191	1.15
0	0.10	0.42	1.08
8	0.12	0.46	...
92	0.208	0.670	1.01
0	0.30	0.80	0.98
0	0.40	0.93	0.96
0	0.50	0.99	0.95
0	0.60	1.01	0.94
0	0.70	0.99	0.94
0	0.80	0.95	0.94
95	0.905	0.842	0.96
2	0.980	0.514	0.97

Ethylidene Chloride and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

wt. %	Gms. $\text{CH}_2\text{CHCl}_2$	Gms. $\text{H}_2\text{O}$	Gms. $\text{C}_2\text{H}_5\text{OH}$	Sp. Gr. Sat. Sol.
	0.985	0.015	0.226	1.10
	0.90	0.10	0.43	1.03
	0.805	0.195	0.586	1.01
	0.70	0.30	0.69	0.98
	*0.67	0.33	0.72	...
	0.60	0.40	0.77	0.96
	0.50	0.50	0.82	0.95
	0.437	0.563	0.857	0.94
	0.30	0.70	0.88	0.93
	0.20	0.80	0.86	0.93
	0.10	0.90	0.79	0.94
	0.03	0.97	0.576	0.95

SOLUBILITY OF ETHYL ALCOHOL (see Note, p. 287) AT 0° WITH MIXTURES OF:  
Heptane and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

wt. %	Gms. $\text{H}_2\text{O}$	Gms. $\text{C}_7\text{H}_{14}$	Sp. Gr. Sat. Sol.
62	0.038	0.704	0.79
0	0.10	1.44	0.80
98	0.202	2.375	0.82
0	0.30	2.82	0.81
0	0.40	3.06	0.82
0	0.50	3.16	0.83
0	0.60	3.17	0.84
0	0.70	3.10	0.85
96	0.804	2.96	0.87
93	0.907	2.305	0.88

Hexane and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

wt. %	Gms. Hexane.*	Gms. $\text{H}_2\text{O}$	Gms. $\text{C}_2\text{H}_5\text{OH}$	Sp. Gr. Sat. Sol.
	0.97	0.03	0.59	...
	0.90	0.10	1.30	0.77
	0.80	0.20	2.04	0.79
	0.70	0.30	2.45	0.81
	0.60	0.40	2.73	0.82
	0.50	0.50	2.93	0.83
	0.40	0.60	3.00	0.83
	0.20	0.80	2.75	0.85
	0.10	0.90	2.23	0.86
	0.014	0.986	1.056	...

\* Kahlbaum's Heptane and Hexane "aus Petroleum" were used.

SOLUBILITY OF ETHYL ALCOHOL (see Note, p. 287) AT 0° WITH MIXTURES OF:  
Amyl Alcohol and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

wt. %	Gms. $\text{H}_2\text{O}$	Gms. $\text{C}_5\text{H}_{11}\text{OH}$	Sp. Gr. Sat. Sol.
23	0.097	0.116	0.84
0	0.10	0.12	0.84
77	0.203	0.258	0.85
4	0.306	0.396	0.86
12	0.398	0.427	0.88
7	0.503	0.449	0.89
9	0.601	0.453	0.90
4	0.706	0.434	0.92
	0.73	0.43	...
5	0.804	0.411	0.94
	0.900	0.369	0.96

Isobutyl Alcohol and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

wt. %	Gms. $(\text{CH}_3)_2\text{CH}.\text{CH}_2\text{OH}$	Gms. $\text{H}_2\text{O}$	Gms. $\text{C}_2\text{H}_5\text{OH}$	Sp. Gr. Sat. Sol.
	0.70	0.30	0.13	0.87
	0.589	0.411	0.177	0.89
	0.502	0.498	0.194	0.90
	0.50	0.50	0.20	0.90
	0.40	0.60	0.20	0.92
	0.387	0.613	0.204	0.92
	*0.35	0.65	0.21	...
	0.304	0.696	0.205	0.94
	0.30	0.70	0.21	0.94
	0.20	0.80	0.20	0.95
	0.132	0.868	0.189	0.96



MISCIBILITY OF ETHYL ALCOHOL (see Note, p. 287) AT 0° WITH MIXTURES OF  
 Isoamyl Bromide and Water. (Bonner, '10.)    Isobutyl Bromide and Water. (Bonner, '10.)

Composition of Homogeneous Mixtures.				Composition of Homogeneous Mixtures.		
Gms. $C_5H_{11}Br$ .	Gms. $H_2O$ .	Gms. $C_2H_5OH$ .	Sp. Gr. Sat. Sol.	Gms. $(CH_3)_2CHCH_2Br$ .	Gms. $H_2O$ .	Gms. $C_2H_5OH$ .
0.975	0.025	0.251	1.10	0.976	0.024	0.200
*0.96	0.04	0.36	...	*0.93	0.07	0.42
0.90	0.10	0.68	1.01	0.90	0.10	0.52
0.80	0.20	1.09	0.96	0.80	0.20	0.83
0.70	0.30	1.37	0.94	0.70	0.30	1.05
0.60	0.40	1.57	0.93	0.60	0.40	1.21
0.498	0.502	1.676	0.91	0.501	0.499	1.30
0.40	0.60	1.75	0.91	0.40	0.60	1.35
0.30	0.70	1.75	0.91	0.30	0.70	1.36
0.20	0.80	1.71	0.91	0.20	0.80	1.32
0.10	0.90	1.46	0.92	0.10	0.90	1.20
0.022	0.978	1.027	0.93	0.047	0.953	0.937

MISCIBILITY OF ETHYL ALCOHOL (see Note, p. 287) AT 0° WITH MIXTURES OF  
 Isoamyl Ether and Water. (Bonner, '10.)    Mesitylene and Water. (Bonner, '10.)

Composition of Homogeneous Mixtures.				Composition of Homogeneous Mixtures.			
Gms. $[(CH_3)_2CHCH_2CH_2CH_2]_2O$ .	Gms. $H_2O$ .	Gms. $C_2H_5OH$ .	Sp. Gr. Sat. Sol.	Gms. $C_6H_2(CH_3)_3$ .	Gms. $H_2O$ .	Gms. $C_2H_5OH$ .	Sp. Gr. Sat. Sol.
0.958	0.042	0.368	0.81	*0.97	0.03	0.48	...
0.90	0.10	0.70	0.82	0.963	0.037	0.516	...
*0.89	0.11	0.74	...	0.90	0.10	1.09	...
0.879	0.121	0.793	0.82	0.80	0.20	1.66	...
0.80	0.20	1.20	0.83	0.70	0.30	2.04	...
0.702	0.298	1.573	0.83	0.60	0.40	2.32	...
0.594	0.406	1.876	0.84	0.50	0.50	2.52	...
0.50	0.50	1.98	0.84	0.40	0.60	2.64	...
0.40	0.60	2.19	0.85	0.30	0.70	2.68	...
0.302	0.698	2.24	0.86	0.199	0.801	2.49	...
0.20	0.80	2.14	0.87	0.10	0.90	2.28	...
0.10	0.90	1.87	0.89	0.051	0.949	1.615	...

MISCIBILITY OF ETHYL ALCOHOL (see Note, p. 287) AT 0° WITH MIXTURES OF  
 Methyl Aniline and Water. (Bonner, '10.)    Phenetol and Water. (Bonner, '10.)

Composition of Homogeneous Mixtures.				Composition of Homogeneous Mixtures.			
Gms. $CH_3NHC_6H_5$ .	Gms. $H_2O$ .	Gms. $C_2H_5OH$ .	Sp. Gr. Sat. Sol.	Gms. $C_6H_5OC_2H_5$ .	Gms. $H_2O$ .	Gms. $C_2H_5OH$ .	Sp. Gr. Sat. Sol.
0.959	0.041	0.218	0.96	0.992	0.18	0.157	...
0.90	0.10	0.37	0.95	*0.90	0.10	0.55	...
0.795	0.205	0.555	0.93	0.897	0.103	0.554	...
0.70	0.30	0.68	0.93	0.798	0.202	0.916	...
*0.66	0.34	0.72	...	0.70	0.30	1.18	...
0.60	0.40	0.76	0.93	0.60	0.40	1.39	...
0.50	0.50	0.84	0.93	0.495	0.505	1.518	...
0.40	0.60	0.89	0.93	0.399	0.601	1.560	...
0.30	0.70	0.91	0.93	0.30	0.70	1.54	...
0.20	0.80	0.87	0.94	0.198	0.802	1.449	...
0.098	0.902	0.734	0.95	0.10	0.90	1.21	...
0.041	0.959	0.581	0.96	0.082	0.918	1.156	...



SOLUBILITY OF ETHYL ALCOHOL (see Note p. 287) AT 0° WITH MIXTURES OF:

and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. Sat. Sol.
	0.010	0.268	0.87
5	0.015	0.47	...
7	0.103	1.595	0.85
5	0.205	2.268	0.84
1	0.30	2.67	0.84
1	0.40	2.94	0.85
13	0.507	3.135	0.85
13	0.607	3.126	0.86
13	0.707	3.038	0.86
14	0.806	2.799	0.87
14	0.906	2.331	0.89
15	0.965	1.639	0.91

Propyl Bromide and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

	Gms. CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> Br.	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. Sat. Sol.
	0.975	0.025	0.190	1.26
	*0.92	0.08	0.42	...
	0.90	0.10	0.50	1.12
	0.80	0.20	0.72	1.06
	0.70	0.30	0.88	1.02
	0.60	0.40	1.01	0.99
	0.50	0.50	1.10	0.98
	0.40	0.60	1.15	0.96
	0.30	0.70	1.14	0.95
	0.204	0.796	1.12	0.94
	0.096	0.904	1.02	0.94
	0.027	0.973	0.687	0.95

SOLUBILITY OF ETHYL ALCOHOL (see Note p. 287) AT 0° WITH MIXTURES OF:

and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. Sat. Sol.
18	0.052	0.388	0.87
3	0.10	0.61	0.86
3	0.20	0.95	0.86
3	0.30	1.21	0.86
3	0.40	1.41	0.86
3	0.50	1.53	0.87
3	0.60	1.59	0.87
3	0.70	1.56	0.88
3	0.80	1.44	0.89
3	0.90	1.23	0.91
28	0.972	0.817	0.94

*o* Toluidine and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

	Gms. CH <sub>3</sub> C <sub>6</sub> H <sub>4</sub> NH <sub>2</sub> .	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. Sat. Sol.
	0.954	0.046	0.025	1.01
	0.90	0.10	0.21	0.93
	0.80	0.20	0.32	0.97
	0.70	0.30	0.41	0.96
	0.60	0.40	0.455	0.96
	0.50	0.50	0.48	0.96
	0.40	0.60	0.50	0.96
	0.30	0.70	0.50	0.96
	0.20	0.80	0.49	0.96
	0.098	0.902	0.462	0.98
	0.027	0.973	0.262	...

SOLUBILITY OF ETHYL ALCOHOL (see Note p. 287) AT 0° WITH MIXTURES OF:

*o*-Toluene (b. pt. 182-3) and Water.

(Bonner, 1910.)

Composition of Homogeneous Mixtures.

	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. Sat. Sol.
8	0.02	0.33	...
51	0.049	0.522	1.09
3	0.10	0.87	1.06
3	0.20	1.28	0.97
3	0.30	1.54	0.94
3	0.40	1.71	0.93
3	0.50	1.81	0.92
3	0.60	1.89	0.91
3	0.70	1.89	0.90
3	0.80	1.78	0.90
3	0.90	1.533	0.91
3	0.967	1.307	0.92

*p* Nitrotoluene and Water.

(Bonner, 1910.)

Composition of Homogeneous Mixtures.

	Gms. NO <sub>2</sub> C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> .	Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH.	Sp. Gr. Sat. Sol.
	0.978	0.022	0.253	1.08
	*0.95	0.05	0.50	...
	0.90	0.10	0.84	0.97
	0.80	0.20	1.29	0.96
	0.70	0.30	1.57	0.92
	0.60	0.40	1.73	0.91
	0.506	0.494	1.782	0.91
	0.398	0.602	1.868	0.91
	0.294	0.706	1.816	0.91
	0.20	0.80	1.63	0.91
	0.10	0.90	1.30	0.92
	0.056	0.944	1.105	0.93



## MISCIBILITY OF ETHYL ALCOHOL (see Note p. 287) AT 0° WITH MIXTURES OF:

*o* Xylene and Water. (Bonner, 1910.)  
Composition of Homogeneous Mixtures.

Gms. $C_6H_4(CH_3)_2$	Gms. $H_2O$	Gms. $C_2H_5OH$	Sp. Gr. Sat. Sol.
0.971	0.029	0.352	0.89
*0.96	0.04	0.53	...
0.90	0.10	0.93	0.87
0.786	0.214	1.32	0.87
0.70	0.30	1.53	0.87
0.60	0.40	1.72	0.87
0.50	0.50	1.87	0.87
0.40	0.60	1.96	0.88
0.30	0.70	1.94	0.88
0.20	0.80	1.81	0.89
0.031	0.969	1.19	0.93

*m* Xylene and Water. (Bonner, 1910.)  
Composition of Homogeneous Mixtures.

Gms. $C_6H_4(CH_3)_2$	Gms. $H_2O$	Gms. $C_2H_5OH$	Sp. Gr. Sat. Sol.
0.967	0.033	0.388	0.88
0.90	0.10	0.81	0.87
0.80	0.20	1.30	0.85
0.70	0.30	1.61	0.86
0.60	0.40	1.77	0.86
0.50	0.50	1.90	0.87
0.40	0.60	1.98	0.87
0.30	0.70	2.01	0.88
0.20	0.80	1.87	0.89
0.10	0.90	1.53	0.90
0.023	0.977	1.168	0.92

Additional data for the system ethyl alcohol, *m* xylene, water at 0°, 19°, 41°, 63° and 100° are given by Holt and Bell, 1914.*p* XYLENE AND WATER. (Bonner, 1910.)

Composition of Homogeneous Mixtures.

Gms. $C_6H_4(CH_3)_2$	Gms. $H_2O$	Gms. $C_2H_5OH$	Sp. Gr. Sat. Sol.
*0.966	0.034	0.306	0.84
*0.92	0.08	0.57	...
0.90	0.10	0.65	0.85
0.80	0.20	1.05	0.85
0.70	0.30	1.35	0.85
0.60	0.40	1.56	0.85

Composition of Homogeneous Mixtures.

Gms. $C_6H_4(CH_3)_2$	Gms. $H_2O$	Gms. $C_2H_5OH$	Sp. Gr. Sat. Sol.
0.50	0.50	1.68	0.86
0.40	0.60	1.77	0.86
0.292	0.702	1.743	0.87
0.193	0.807	1.625	0.88
0.100	0.90	1.39	0.89
0.015	0.985	0.863	0.93

The coefficient of distribution of ethyl alcohol between olive oil and water is 0.026 at 3° and 0.047 at 30°.

(Meyer, 1901; 1909)

100 gms. cottonseed oil (0.922 Sp. Gr.) dissolve 22.9 gms. ethyl alcohol at 25°.

100 gms. ethyl alcohol dissolve 11.75 gms. cottonseed oil at 25°. (Wroth and Reid, '16)

## DISTRIBUTION OF ETHYL ALCOHOL BETWEEN COTTONSEED OIL AND WATER AT 25°. (Wroth and Reid, 1916.)

Gms. $C_2H_5OH$ per 100 cc.		Ratio.
Oil Layer.	$H_2O$ Layer.	
0.2083	6.147	29.5
0.2251	6.738	29.9
0.2515	6.835	27.1
0.2783	6.876	24.7
0.3017	8.682	28.7

Data for the reciprocal solubility of ethyl alcohol and turpentine are given by Vèzes and Mouline, 1904, 1905-06.

Data for the system ethyl alcohol, water, petroleum are given by Rodt (1916)

**ETHYLAMINES**  $C_2H_5.NH_2$ ,  $(C_2H_5)_2NH$ ,  $(C_2H_5)_3N$ .

Freezing-point data (solubility, see footnote, p. 1) for mixtures of ethylamine + water, diethylamine + water, and triethylamine + water are given by Guthrie 1884 and by Pickering, 1893.

The solubility of ethylamine and of diethylamine in water at 60°, calculated from the vapor pressures determined by an aspiration method, are given by Doye (1890) as follows:

Amine.	Vapor Pressure in mm. Hg.	Ostwald Solubility Ex. 1 (see p. 227.)	Bunsen Absorption Coef. (see p. 227.)
$C_2H_5NH_2$	64.5	321	263
$(C_2H_5)_2NH$	233	89	73

Data for the solubility of triethylamine in water at high pressures are given by Kohnstamm and Timmermans, 1913.



# SOLUBILITIES OF DI ETHYL AMINE AND WATER.\*

Latour — Phil. Mag. [6] 10, 398, '05.)

t°.	Gms. $\text{NH}(\text{C}_2\text{H}_5)_2$ per 100 Gms.	
	Aqueous Layer.	Amine Layer.
55	21.7	59.0
50	23.6	55.5
48	24.8	53.5
46	26.3	51.0
45	28.0	49.0
44	31.0	45.0
43.5 (crit. t.)	37.4	

# DISTRIBUTION OF TRI ETHYL AMINE BETWEEN WATER AND AMYL ALCOHOL AT 25°.

(Herz and Fischer — Ber. 37, 4751, '04.)

Gms. $\text{N}(\text{C}_2\text{H}_5)_3$ per 100 cc.		Millimols $\text{N}(\text{C}_2\text{H}_5)_3$ per 10 cc.	
Aqueous Layer.	Alcoholic Layer.	Aqueous Layer.	Alcoholic Layer.
0.0885	2.299	0.0875	2.273
0.1683	4.457	0.1664	4.408
0.1866	4.922	0.1846	4.868
0.2502	6.491	0.2474	6.418

# TriethylAMINE $\text{N}(\text{C}_2\text{H}_5)_3$ .

## SOLUBILITY IN WATER.\*

(Rothmund, 1898.)

t°.	Gms. $\text{N}(\text{C}_2\text{H}_5)_3$ per 100 Gms.		t°.	Gms. $\text{N}(\text{C}_2\text{H}_5)_3$ per 100 Gms.	
	Aq. Layer.	Amine Layer.		Aq. Layer.	Amine Layer
18.6 (crit. temp.)		51.9	40	3.65	96.48
20	14.24	72	50	2.87	96.4
25	7.30	95.18	55	2.57	96.3
30	5.80	96.60	60	2.23	96.3
35	4.58	96.5	65	1.97	96.3

# SOLUBILITY OF TRIETHYLAMINE IN WATER AND IN Aq. ETHYL ALCOHOL AT DIFFERENT TEMPERATURES.\*

(Meerburg, 1902.)

Water.		23.13% Alcohol.		28.98% Alcohol.		38.84% Alcohol.		60.16% Alcohol.	
t°.	Gm. N(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> per 100 Gms. Sol.	t°.	Gm. N(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> per 100 Gms. Sol.	t°.	Gm. N(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> per 100 Gms. Sol.	t°.	Gm. N(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> per 100 Gms. Sol.	t°.	Gm. N(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> per 100 Gms. Sol.
69.2	1.7	38.3	8.2	54.5	22.8	73.4	31.2	76-77	71.2
30.8	5.6	31.7	13.9	45	29.8	65.4	33.3	74-75	75
23.1	8.5	28	21.6	33.4	51.1	51.6	40.6	72-73	80
18.7	25.8	26.4	30.6	31.4	63.7	42.1	50.6		
18.7	37.2	24.9	40.5	30.3	68.5	40.9	54.7		
19.5	51.8	24.2	49.8	28.5	82.2	34.2	70.6		
20.5	68.6	24.1	60.7	35	91.8	33	77.5		
20.5	84	24	69.7			34.7	88		
20.5	89.7	23.5	76.6			40.5	91.3		
21.2	92.4	24	81.5						
25.8	95.5	24.2	87.4						
26.5	96.1	25	92						

NOTE. — Results for triethylamine, water and ethyl ether, and for triethylamine, water and phenol are also given by Meerburg.

100 gms. abs. methyl alcohol dissolve 57.5 gms.  $\text{NH}(\text{C}_2\text{H}_5)_2$  at 19.5°.

100 gms. abs. ethyl alcohol dissolve 56 gms.  $\text{NH}(\text{C}_2\text{H}_5)_2$  at 19.5°.

(de Bruyn, 1892.)

\* Determinations made by "Synthetic Method," see Note, p. 16.



DISTRIBUTION OF ETHYLAMINES BETWEEN WATER AND 1  
(Moore and Winnill, 1912.)

Amine.	Results at 18°.		Results at 25°.		Res
	Gms. Equiv. per Liter Aq. Layer.	Partition Coef.	Gms. Equiv. per Liter Aq. Layer.	Partition Coef.	
(C <sub>2</sub> H <sub>5</sub> )NH <sub>2</sub>	0.0756	26.09	0.1159	19.13	0.1
"	0.0886	26.14	0.0999	19.11	0.2
(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> NH	0.0484	2.14	0.0483	1.59	0.1
"	0.0503	2.14	0.0416	1.59	0.1
(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> N	0.0189	0.131	0.0104	0.099	0.0
"	0.0191	0.131	0.0131	0.099	0.0

Similar data for triethylamine at 25° and at other temperatures are given by Hantzsch and Sebaladt, 1899, and by Hantzsch and Vagt, 1901.

Data for ternary systems composed of triethylamine, water and the following compounds: naphthalene, cane sugar, KCl, K<sub>2</sub>CO<sub>3</sub>, K<sub>2</sub>SO<sub>4</sub> are given by Timmermans (1907).

## ETHYL, DIETHYL and TRIETHYLAMINE HYDROCHLORIDES

SOLUBILITY OF EACH IN WATER AND IN CHLOROFORM  
(Peddle and Turner, 1913.)

Amine Salt.	Formula.	Solubility in Water. Gms. Amine Salt per 100 Gms. H <sub>2</sub> O.
Ethylamine Hydrochloride	C <sub>2</sub> H <sub>5</sub> .NH <sub>2</sub> .HCl	279.9
Diethylamine	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> NH.HCl	231.7
" Hydrobromide	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> NH.HBr	311.6
" Hydroiodide	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> NH.HI	377.2
Triethylamine Hydrochloride	(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> N.HCl	137
" Hydrobromide	(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> N.HBr	150.6
" Hydriodide	(C <sub>2</sub> H <sub>5</sub> ) <sub>3</sub> N.HI	370

ETHYL BROMIDE C<sub>2</sub>H<sub>5</sub>Br.

## SOLUBILITY IN ETHER. (Parmentier, 1892.)

	t°.	-13°.	0.	12.
Gms. C <sub>2</sub> H <sub>5</sub> Br per 100 gms. Ether	632	561	462	

SOLUBILITY OF ETHYL BROMIDE, ETC., IN WATER  
(Rex, 1906.)

Dissolved Substance.	Grams per 100 Grams H <sub>2</sub> O at:		
	0°.	10°.	20°.
Ethyl Bromide	1.067	0.965	0.914
Ethyl Iodide	0.441	0.414	0.403
Ethylene Chloride	0.922	0.885	0.869
Ethylidene Chloride	0.656	0.595	0.550

ETHYL BUTYRATE C<sub>2</sub>H<sub>5</sub>COOC<sub>2</sub>H<sub>5</sub>.

## SOLUBILITY IN WATER AND IN AQUEOUS ETHYL ALCOHOL MIXTURES

100 g. H<sub>2</sub>O dissolve 0.5 g. ethyl butyrate at 22°.

100 cc. H<sub>2</sub>O dissolve 0.8 cc. ethyl butyrate at 20°.

100 cc. ethyl butyrate dissolve 0.4 - 0.5 cc. H<sub>2</sub>O at 20°.

Per 5 cc.	(cc. H <sub>2</sub> O	10	6	4
Ethyl Alcohol	{ cc. C <sub>2</sub> H <sub>5</sub> COOC <sub>2</sub> H <sub>5</sub>	0.34	0.96	2.47

ETHYL CARBAMATE (Urethan) CO(OC<sub>2</sub>H<sub>5</sub>)NH<sub>2</sub>. See also

## SOLUBILITY IN SEVERAL SOLVENTS AT 25°. (U. S. P.)

Solvent.	Water.	Alcohol.	Ether.	Chloroform.
Gms. CO(OC <sub>2</sub> H <sub>5</sub> )NH <sub>2</sub> per 100 gms. solvent	100+	166	100	1



ETHYL ETHER ( $\text{C}_2\text{H}_5)_2\text{O}$ .

## RECIPROCAL SOLUBILITY OF ETHER AND WATER.

*Ann. — Z. physik. Chem.* 24, 619, '97; Schuncke — *Ibid.* 24, 334, '94; St. Tolloczko — *Ibid.* 20, 407, '96.)

Solubility of Ether in Water.  
Lower Layer — Aqueous.

t°.	Gms. ( $\text{C}_2\text{H}_5)_2\text{O}$ per 100 Gms.	
	Water.	Solution.
0	13.12	11.6
5	11.4	10.2
10	9.5	8.7
15	8.2	7.6
20	6.95	6.5
25	6.05	5.7
30	5.4	5.1
*40	4.7	4.5
*50	4.3	4.1
*60	3.8	3.7
*70	3.3	3.2
*80	2.9	2.8

Solubility of Water in Ether.  
Upper Layer — Ethereal.

	Gms. $\text{H}_2\text{O}$ per 100 Gms.	
	Ether.	Solution.
0	1.01	1.0
5	1.06	1.05
10	1.12	1.12 (2.6, S.)
15	1.16	1.15
20	1.20	1.20 (2.65, S.)
25	1.26	1.26
30	1.33	1.32
40	1.52	1.50
50	1.73	1.7
60	1.83	1.8
70	2.04	2.0
80	2.25	2.2

\* Indicates determinations made by Synthetic Method, for which see page 28.

100 cc.  $\text{H}_2\text{O}$  dissolve 8.11 cc. ether at 22°; vol. of solution, 107.145 cc., Sp. Gr. 0.9853.

100 cc. ether dissolve 2.93 cc.  $\text{H}_2\text{O}$  at 22°; vol. of solution, 103.282 cc.; Sp. Gr. 0.7164. (Herz, 1898.)

More recent determinations of the solubility of ethyl ether in water, agreeing closely with the above data, are given by Osaka, 1910.

Data for the temp.-pressure diagram of ether-water are given by Scheffer, 1912a.

## SOLUBILITY OF ETHER IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID.

(Schuncke — *Z. physik. Chem.* 24, 334, '94; in 38.52% HCl, Draper — *Chem. News* 35, 87, '77.)

In 38.52% HCl.

In 31.61% HCl.

In 20% HCl.

t°.	cc. Ether per 100 cc. Solvent.	cc. Ether per 100 cc. Solvent.	Gms. per 1 Gram $\text{H}_2\text{O}$ .		cc. Ether per 100 cc. Solvent.	Gms. per 1 g. $\text{H}_2\text{O}$ .	
			HCl.	( $\text{C}_2\text{H}_5)_2\text{O}$ .		HCl.	( $\text{C}_2\text{H}_5)_2\text{O}$ .
-6	181	149	0.4622	1.387	67.2	0.253	0.5637
0	177.5	142	0.4622	1.308	58.3	0.253	0.4863
+6	172.5	131.5	0.4622	1.2075	51.1	0.253	0.4231
15	163	121.7 (14°)	0.4622	1.1075	40.5	0.253	0.3299
20	158	111.9 (20.8°)	0.4622	1.0005	33.1	0.253	0.2688
26	135	104.2	0.4622	0.9360	27.5	0.253	0.2221

In 12.58% HCl.

In 3.65% HCl.

t°.	cc. Ether per 100 cc. Solvent.	Gms. per 1 Gram $\text{H}_2\text{O}$ .		cc. Ether per 100 cc. Solvent.	Gms. per 1 Gram $\text{H}_2\text{O}$ .	
		HCl.	( $\text{C}_2\text{H}_5)_2\text{O}$ .		HCl.	( $\text{C}_2\text{H}_5)_2\text{O}$ .
-6	26.45	0.144	0.2106	19.23	0.0308	0.1454
0	22.19	0.144	0.1748	...	...	...
+6	19.18	0.144	0.1503	14.31	0.0308	0.1070
15	15.61	0.144	0.1210	11.83	0.0308	0.0868
20	13.76	0.144	0.1059	10.52	0.0308	0.0769
26	12.70	0.144	0.0970	9.24	0.0308	0.0673

The above data are recalculated and discussed by Jüttner, 1901.



Data for the solubility of ethyl ether in carbon dioxide at high pressures given by Sander (1911-12). The determinations were made by using quite small amounts of ether and observing the pressure at which a drop of liquid appeared or disappeared in a mixture of known weight per cent composition. The results give the "gas curve" for constant temperature and when plotted in connection with the "liquid curve" (see CO<sub>2</sub>, p. 233), give the complete pressure-concentration diagram.

Freezing-point lowering data for mixtures of ethyl ether and hydrochloric acid are given by Maass and McIntosh (1913).

#### SOLUBILITY OF ETHER IN AQUEOUS SALT, ETC., SOLUTIONS AT 18°.

(Euler, 1904.)

Aq. Solution of:	Gms. per Liter Added Salt.	Gms. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O per 100 cc. Solvent.	Aq. Solution of:	Gms. per Liter Added Salt.	Gms. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O per 100 cc. Solvent.
Water	0	7.8	Na <sub>2</sub> SO <sub>4</sub>	59.54	3.7
KNO <sub>3</sub>	101.19	5.4	Mannite	91.06	6.7
KCl	73.6	4.7	H <sub>2</sub> SO <sub>4</sub>	49	6.6
LiCl	42.48	5.2	"	122.5	5.65
NaCl	58.5	4.5	"	245.	4.55

#### SOLUBILITY OF ETHYL ETHER IN AQ. SALT SOLUTIONS AT 28°.

(Thorin, 1915.)

Solvent.	Gms. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O per 100 cc. Solvent.	Solvent.	Gms. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O per 100 cc. Solvent.	Solvent.	Gms. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O per 100 cc. Solvent.
Water	5.85	0.5% Na <sub>2</sub> PO <sub>4</sub>	4.17	0.5% Na Succinate	4.68
0.5% NaI	5.70	0.5% Na <sub>2</sub> AsO <sub>4</sub>	4.20	0.5% Na Citrate	4.19
0.5% NaBr	4.68	0.5% Hg(CN) <sub>2</sub>	5.71	0.5% Na Acetate	4.15
0.5% NaCl	4.48	0.5% NH <sub>4</sub> NO <sub>3</sub>	5.37	0.5% Na Tartrate	4.12
0.5% NaF	4.15	0.5% FeCl <sub>3</sub>	5.09	0.5% Na Phthalate	5.88
0.5% Na <sub>2</sub> SO <sub>4</sub>	4.30	0.5% Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	4.84	0.5% Na Cinnamate	6.29
0.5% Na <sub>2</sub> CrO <sub>4</sub>	4.22	0.5% FeSO <sub>4</sub>	4.33	0.5% Na Benzoate	5.99
0.5% Na <sub>2</sub> MoO <sub>4</sub>	4.39	0.5% Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	3.95	0.5% Na Salicylate	6.44
0.5% Na <sub>2</sub> WO <sub>4</sub>	4.12	0.5% Am. Oxalate	4.74	0.5% Na Benzene Sulfonate	6.05

#### SOLUBILITY OF ETHYL ETHER IN 0.91 PER CENT (PHYSIOLOGICAL NORMAL SALINE) AQUEOUS NaCl SOLUTION.

(Beaumont, 1912.)

Determinations made by freezing-point method. Ether of  $d_{15} = 0.720$  used.

t°.	Gms. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O per 100 Gms. Aq. NaCl.	cc. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O (at 15°) per 100 cc. Aq. NaCl.
0	13.08	18.27
5	11.15	15.58
10	9.45	13.20
15	8.10	11.31
20	6.87	9.60
25	5.96	8.33
30	5.30	7.40

Purified ether prepared from methylated spirit gave slightly higher results.

#### SOLUBILITY OF ETHYL ETHER IN AQ. SULFURIC ACID AT 0°.

(Kremann, 1910a.)

Gms. per 100 Gms. Homogeneous Mixture.			Gms. per 100 Gms. Homogeneous Mixture.		
(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	H <sub>2</sub> O.	H <sub>2</sub> SO <sub>4</sub> .	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	H <sub>2</sub> O.	H <sub>2</sub> SO <sub>4</sub> .
24.2	34.5	41.3	16.1	42.7	41.2
24.8	35.4	39.8	6.1	78	15.9
43.9	15.7	40.4	53.8	8.5	37.7
34	26.1	39.9			

Data for the system ethyl ether, ethyl alcohol, water, sulfuric acid at 0° are given.



**SOLUBILITY OF ETHER IN AQUEOUS ETHYL ALCOHOL AND IN AQUEOUS METHYL ALCOHOL MIXTURES AT 20°.**

(Bancroft, 1895.)

In Ethyl Alcohol.			In Methyl Alcohol.		
cc. $C_2H_5OH$ .	Per 5 cc. $C_2H_5OH$ .		Per 1 cc. $CH_3OH$ .	Per 1 cc. $CH_3OH$ .	
cc. $(C_2H_5)_2O$ .	cc. $H_2O$ .	cc. $(C_2H_5)_2O$ .	cc. $H_2O$ .	cc. $(C_2H_5)_2O$ .	cc. $(C_2H_5)_2O$ .
1.30	4.45	7	10	1.13	0.83
1.70	4	7.8	7	0.85	0.64
2.41	3.87	8	4	0.60	0.52
3.35	3.10	10	2.5	0.56	0.44
5.10	2.08	15	1.8	0.63	0.45
11	6	17.5	1	1.23	

\* Saturated with ether.

† Saturated with water.

**SYSTEM ETHYL ETHER-MALONIC ACID-WATER AT 15°.** (Klobbie, 1897.)

Results for the Liquid Layers in Contact with Excess of Malonic Acid.

per 100 Gms. Lower Layer.			Gms. per 100 Gms. Upper Layer.			Gms. per 100 Gms. Liquid.			Solid Phase.
ml.	H <sub>2</sub> O.	Ethyl Ether.	Malonic Acid.	H <sub>2</sub> O.	Ethyl Ether.	Malonic Acid.	H <sub>2</sub> O.	Ethyl Ether.	Malonic Acid
1	92.23	7.77	0	1.20	98.80	8	0	92	"
3	87.42	7.94	0.72	1.54	97.74	9.96	0.42	89.61	"
10	79.92	8.48	2.19	1.99	95.82	19.41	2.79	77.80	"
15	69.55	9.99	5.01	3.08	91.91	27.22	5.23	67.54	"
18	60.57	12	9.52	5.19	85.29	35.51	10.73	53.75	"
17	47.45	18.80	21.89	13.42	64.91	46.48	20.86	32.66	"
17	35.81	30.02	30.44	25.37	44.19	51.33	26.30	22.36	"
11	26.76	42.12	31.11	26.76	42.12	57.37	39.10	3.52	"

Results for the system ethyl ether, succinic acid nitrile and water are given by Dreier and Winkler, 1898.

Results for the extraction of formic acid from water by ether are given by Dakin, 1913.

**ETHYL FORMATE  $HCOOC_2H_5$ .**

10 grams water dissolve 10 grams ethyl formate at 22°.

(Traube, 1884.)

**ETHYL METHYL KETONE  $CH_3CO.C_2H_5$ .**

SOLUBILITY IN WATER. (Rothmund, 1898.)

by synthetic method, see Note, page 16.

°.	Gms. Ketone per 100 Gms.		°.	Gms. Ketone per 100 Gms.	
	Aq. Layer.	Ketone Layer.		Aq. Layer.	Ketone Layer.
-10	34.5	89.7	90	16.1	84.8
+10	26.1	90	110	17.7	80
30	21.9	89.9	130	21.8	71.9
50	17.5	89	140	26	64
70	16.2	85.7	151.8	(crit. temp.)	44.2

The accuracy of Rothmund's data is questioned by Marshall (1906) and the following new determinations given.

°.	64.7°.	65.5°.	73.6°.	91.0°.	15°.	73.6°.
% Ketone in Mixture	18.15	18.08	18	18.08	88.2	85.05

Results for the reciprocal solubility of ethyl methyl ketone and water, containing ethyl alcohol, are given by Bruni (1899, 1900). This system is of interest particularly on account of having both an upper and a lower critical point.

Boiling-point data for mixtures of ethylmethyl ketone and water are given by Hermann (1911) and by Bruni, 1899, 1900.



**ETHYL KETONE**

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**DIETHYL KETONE** (Propione) ( $C_2H_5$ )<sub>2</sub>CO.

SOLUBILITY IN WATER. (Rothmund, 1898.)

The determinations were made by Synthetic Method, see p. 16. The critic temperature could not be reached and high accuracy is not claimed for the result

t°.	Gms. Diethyl Ketone per 100 Gms.		t°.	Gms. Diethyl Ketone per 100 Gms.	
	Aq. Layer.	Ketone Layer.		Aq. Layer.	Ketone Layer.
20	4.60	...	100	3.68	93.10
40	3.43	97.42	120	4.05	90.18
60	3.08	96.18	140	4.76	87.01
80	3.20	94.92	160	6.10	83.33

**ETHYL PROPIONATE**  $C_2H_5COOC_2H_5$ .

SOLUBILITY IN WATER AND IN AQUEOUS ETHYL ALCOHOL MIXTURES.  
(Pfeiffer, 1892; Bancroft, 1895.)

cc. Alcohol in Mixture.	cc. H <sub>2</sub> O to Cause Separation of a Second Phase in Mixtures of the Given Amounts of Alcohol and 3 cc. Portions of Ethyl Propionate.
3	2.32
6	6.87
9	12.35
12	19.17
15	27.12
18	36.84
21	50.42
24	∞

100 grams H<sub>2</sub>O dissolve 1.7 grams ethyl propionate at 22°. (Traube, 1882)

**DIETHYL DIACETYL TARTRATE**  $(CH_3COCH_2)_2(COOC_2H_5)_2$ .

Freezing-point lowering data (solubility, see footnote, p. 1) for mixtures of diethyl diacetyl tartrate and each of the following compounds are given by Scheuer (1910); *m* nitrotoluene, ethylene bromide, phenol and naphthalene. Results for diethyl diacetyl tartrate and naphthalene are also given by Palazzo and Batelli (1883).

**ETHYL VALERATE**  $C_4H_9COOC_2H_5$ .**ETHYL** (Iso) **VALERATE**  $(CH_3)_2CH.CH_2.COOC_2H_5$ .

SOLUBILITY OF EACH IN WATER AND IN AQUEOUS ALCOHOL MIXTURES AT 20°  
(Pfeiffer, 1892; Bancroft, 1895.)

100 cc. water dissolve 0.3 cc. ethyl valerate at 25°.  
100 cc. water dissolve 0.2 cc. ethyl iso valerate at 20°.  
100 cc. ethyl iso valerate dissolve 0.4+ cc. water at 20°.

Mixtures of Ethyl Alcohol,  
Ethyl Valerate and Water.

Mixtures of Ethyl Alcohol  
Ethyl Iso Valerate and Water

cc. Alcohol.*	cc. H <sub>2</sub> O.†	cc. Alcohol.*	cc. H <sub>2</sub> O.†	Per 5 cc. Ethyl Alcohol.	
				cc. H <sub>2</sub> O.	cc. Ethyl Iso Valerate.
3	1.42	39	53.13	10	0.15
9	7.18	45	63.60	8	0.23
15	14.13	57	90.53	6	0.46
21	22.40	72	131.0	5	0.72
27	31.62	81	180.0	4	1.23
33	41.62				

\* cc. Alcohol in mixture.

† cc. H<sub>2</sub>O added to cause the separation of a second phase in mixtures of the given amounts of alcohol and 3 cc. portions of ethyl valerate.



**ETHYLENE**  $C_2H_4$ . SOLUBILITY IN WATER AND IN ALCOHOL.  
(Bunsen and Carius; Winkler, 1906.)

t°.	$\beta$ .	$\epsilon$ .	Solubility in Alcohol.	
0	0.226	0.0281	t°.	Vols. $C_2H_4$ per 100 Vols. Alcohol.
5	0.191	0.0237	0	359.5
10	0.162	0.0200	4	337.5
15	0.139	0.0171	10	308.6
20	0.122	0.0150	15	288.2
25	0.108	0.0131	20	271.3
30	0.098	0.0118		

For  $\beta$  and  $q$  see Ethane, p. 285.

**SOLUBILITY OF ETHYLENE IN AQUEOUS SOLUTIONS OF ALKALI HYDROXIDES, ETC., AT 15°.** (Billitzer, 1902.)

Results in terms of the Ostwald Solubility Expression  $l$ . See p. 227.

Aqueous Solution of:	Solubility $l_{15}$ in Aq. Solution of Normality:				
	0.1.	0.25.	0.5.	0.75.	1.0.
KOH	0.154	0.144	0.130	0.118	0.1056
NaOH	0.153	0.144	0.128	0.114	0.101
$NH_4OH$	...	0.157	0.156	0.155	0.154
$\frac{1}{2} Na_2SO_4$	0.1525	0.1425	0.127	0.109	0.093
In $H_2O$ alone	0.1593	...	...	...	...

**SOLUBILITY OF ETHYLENE IN METHYL ALCOHOL AND IN ACETONE.** (Levi, 1902.)

Results in terms of the Ostwald Solubility Expression  $l$ . See p. 227.

t°.	In Methyl Alcohol.	In Acetone.	t°.	In Methyl Alcohol.	In Acetone.
0	3.3924	4.0652	30	1.8585	1.8680
10	2.8831	3.3580	40	1.3432	1.0852
20	2.3718	2.6278	50	0.8259	0.2772
25	2.1154	2.2500	60	0.3506	...

The formulas from which the above figures were calculated are:

$$\text{In Methyl Alcohol, } l = 3.3924 - 0.05083 t - 0.00001 \beta.$$

$$\text{In Acetone, } l = 4.0652 - 0.06946 t - 0.000126 \beta.$$

**SOLUBILITY OF ETHYLENE IN SEVERAL SOLVENTS.** (McDaniel, 1911.)

Solvent.	t°.	Abs. Coef. A.	Bunsen Coef. $\beta$ .	Solvent.	t°.	Abs. Coef. A.	Bunsen Coef. $\beta$ .
Benzene	22	3.010	2.786	Heptane	22.4	3.463	3.207
"	35	2.655	2.353	"	35	3.186	2.824
"	50	2.482	2.100	"	39	3.110	2.722
Hexane	22	3.038	2.8141	Acetone	20	2.571	2.290
"	35	2.826	2.505	"	35	2.308	2.046
"	45	2.586	2.219	Limonene	22	no constant equilibrium	

Abs. Coef. A = vol. of ethylene absorbed by unit vol. of solvent at temp. stated.

For definition of Bunsen Coef.  $\beta$ , see carbon dioxide, p. 227.

The Coef. of Abs.  $\beta$  of ethylene in Russian petroleum is 0.164 at 10° and 0.142 at 20°.  
(Gniewosz and Walfas, 1887.)

Freezing-point data (solubility, see footnote, p. 1) for mixtures of ethylene and methyl ether are given by Baume and Germann, 1911, 1914.

**ETHYLENE BROMIDE**  $C_2H_4Br_2$ .

**-PT. DATA FOR MIXTURES OF ETHYLENE BROMIDE AND OTHER COMPOUNDS.**

Ethylene Bromide	+	Naphthalene	(Baud, 1912; Dahms, 1895.)
"	+	$\beta$ Naphthol	(Bruni, 1898.)
"	+	" + Picric Acid	(Bruni, 1898.)
"	+	Paraldehyde	(Paterno and Ampola, 1897.)
"	+	Phenol	(Dahms, 1895; Paterno and Ampola, 1897.)
"	+	Toluene	(Baud, 1912.)
"	+	Bromotoluene	(Paterno and Ampola, 1897.)
"	+	$p$ Xylene	" "



**ETHYLENE CYANIDE**

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**ETHYLENE CYANIDE**  $C_2H_4(CN)_2$ .

DISTRIBUTION BETWEEN WATER AND CHLOROFORM. (Hantzsch and Vay

t°.	Gm. Mols. $C_2H_4(CN)_2$ per Liter.		Ratio, $\frac{c_1}{c_2}$
	Aq. Layer, $c_1$ .	$CHCl_3$ Layer, $c_2$ .	
0	0.0786	0.0464	1.69
10	0.0787	0.0463	1.70
20	0.0791	0.0459	1.72

Additional data for the influence of KOH, KCl and HCl on the abo  
bution are also given.

**DIETHYLENE ETHER**  $(CH_3OCH_2)_2$ .

Freezing-point data (solubility, see footnote, p. 1) are given for mi  
diethylene ether and water, by Unkovskaja, 1913.

**Tetraphenyl ETHYLENE**  $(C_6H_5)_2C:C(C_6H_5)_2$ .

Freezing-point data for tetraphenyl ethylene + silicotetraphenyl are  
Pascal and Normand (1913).

 **$\beta$  EUCAINE**  $C_{18}H_{31}NO_3$  and Salts.

100 cc. $H_2O$ dissolve 0.296 gm. anhydrous $\beta$ eucaine at 20°.	}
100 cc. oil of sesame dissolve 3.49 gms. anhydrous $\beta$ eucaine at 20°.	
100 cc. aniline oil dissolve 66.6 gms. anhydrous $\beta$ eucaine at 20°.	
100 cc. $H_2O$ dissolve 2.5 gms. $\beta$ eucaine hydrochloride at 15-20°	
100 cc. 90% alcohol " 9 " " " " "	
100 cc. $H_2O$ " 25 " " lactate " "	}
100 cc. 90% alcohol " 12.5 " " " " "	
100 cc. $CHCl_3$ " 20 " " " " "	

**EUROPIUM** Bromonitrobenzene **SULFONATE**  $Eu[C_6H_4Br(1)NO_2(4)]$   
 $10H_2O$ .

100 gms. sat. solution in water contain 6.31 gms. anhydrous salt at 25°.  
(Katz and Ja

**FATS.**

SOLUBILITY OF THE FATTY ACIDS OBTAINED FROM SEVERAL SOURC  
ALCOHOL AND IN BENZENE. (Dubois and Pade, 1885.)

Crude Fatty Acid of:	Gms. Fat per 100 Gms. Abs. Alcohol at:			Gms. Fats per 10 Gms. Benzene at 1
	0°.	10°.	26°.	
Mutton	2.48	5.02	67.96	14.70
Beef	2.51	6.05	82.23	15.89
Veal	5	13.78	137.10	26.08
Pork	5.63	11.23	118.98	27.30
Butter	10.61	24.81	158.2	69.61
Margarine	2.37	4.94	47.06	13.53

MISCIBILITY OF FATS AND 90 VOL. PER CENT ALCOHOL AT 37°. (Vandev

Mixtures of fats and alcohol in various proportions were shaken twice  
8 days and the volume of each layer, as well as its composition, determ

Mixture.	Composition of Mixture		Volume after Agitation.		Gms. Fat per G 100 Gms. P Alcohol Layer
	cc. Alcohol	cc. Fat	cc. Alcohol	cc. Fat	
Alcohol + Cocaline	25	5	25.4	4.6	4.9
" "	20	10	19.2	10.8	5.6
" "	15	15	13	17	7.2
" "	10	20	6.7	23.3	9.1
" "	5	25	1.1	28.9	13
Alcohol + Butter Fat	25	5	25.1	4.9	3.5
" "	20	10	19.2	10.8	3.5
" "	15	15	13	17	4
" "	10	20	7.1	22.9	5.7
" "	5	25	2	28	14.1
Alcohol + Olive Oil	25	5	24.7	5.3	2.3
" "	20	10	19.2	10.8	2.4
" "	15	15	13	17	2.4
" "	10	20	7.5	22.5	2.5
" "	5	25	2.2	27.8	7

For other data on the solubility of fats see Ewers (1910) and Louise



**FLUORENE** (Diphenylenemethane)  $C_{14}H_{10}$ 

Freezing-point data (solubility, see footnote, p. 1) are given by Kremann (1911) for mixtures of fluorene and each of the following compounds: *o*, *m* and *p* dinitrobenzene, 1,3,5, trinitrobenzene, dinitrophenol, dinitrotoluene, trinitrotoluene and picric acid.

**FLUORESCIN**  $C_{20}H_{12}O_5$ 

100 gms.  $H_2O$  dissolve 0.005 gm. fluorescein at 20–25° (Dehn, 1917.)

100 gms. pyridine dissolve 13.29 gms. fluorescein at 20–25° “

100 gms. aq. 50% pyridine dissolve 37.22 gms. fluorescein at 20–25° “

**FORMALDEHYDE**, Solid Polymers  $(CH_2O)_n$ .

SOLUBILITY OF THE SIX WELL-DEFINED SOLID POLYMERS OF FORMAL-  
DEHYDE IN WATER. (Auerbach and Barschall, 1908.)

Name.	Formula.	m. pt.	Gms. per 100 cc. Sat. Solution in Water.
Paraformaldehyde	$(CH_2O)_n + xH_2O$	150–160	20–30 gms. at 18°
$\alpha$ Polyoxymethylene	$(CH_2O)_n$	163–8	11 gms. at 18–25°
$\beta$ Polyoxymethylene	$(CH_2O)_n$	163–8	3.3 gms. at 18°, about 4 at 25°
$\gamma$ Polyoxymethylene	$(CH_2O)_n$	163–5	less than 0.1 at 18°, 0.1 gm. at 25°
$\delta$ Polyoxymethylene	$(CH_2O)_n$	169–70	practically insoluble
$\epsilon$ Trioxymethylene	$C_3H_4O_3$	63–4	17.2 at 18°, 21.1 at 25°

All are insoluble in alcohol and ether except trioxymethylene.

SOLUBILITY OF TRIOXYMETHYLENE IN AQ. SODIUM SULFITE SOLUTIONS AT 15°.  
(Lumière and Seyewetz, 1902.)

Gms.  $Na_2SO_3$  per 100 cc.  $H_2O$       5      10      20      25      28 (sat.)

Gms.  $C_3H_4O_3$  per 100 cc. sat. sol.      22      24      26      27      27

Data are also given for the solubility of various mixtures of trioxymethylene and sodium sulfite in water at 15°.

The distribution coefficient of formaldehyde between water and ether is 8.5 at 6° and 9.23 at 20°.

(Hantzsch and Vagt, 1901.)

**FORMAMIDE**  $HCONH_2$ .

SOLUBILITY IN WATER, DETERMINED BY THE FREEZING-POINT METHOD.  
(English and Turner, 1915.)

$t^\circ$ of Solid.	Gms. $HCONH_2$ per 100 Gms. $H_2O$ .	Solid Phase.	$t^\circ$ of Solidif.	Gms. $HCONH_2$ per 100 Gms. $H_2O$ .	Solid Phase.	$t^\circ$ of Solidif.	Gms. $HCONH_2$ per 100 Gms. $H_2O$ .	Solid Phase.
–0	0	Ice	–31.1	116.4	Ice	–37.6	267	$HCONH_2$
–2.7	9.93	“	–42.5	169	“	–29.4	369.8	“
–5.7	17.87	“	–45.4	187.8	$HCONH_2 \cdot H_2O$	–21.9	540.3	“
–11	35.45	“	–40.4	218.3	“	–14.5	836.8	“
–23.6	81.93	“	–40	241.4	“	–6.4	1780	“

Similar data are also given for formamide + formic acid and formamide + propionic acid.

*o* and *p* Chloro**FORMANILIDES**  $Cl \cdot C_6H_4NH \cdot CHO$ .

Freezing-point lowering data for mixtures of *o* and *p* chloroformanilide are given by King and Orton, 1911.

**FORMIC ACID**  $HCOOH$ .

SOLUBILITY IN WATER, DETERMINED BY FREEZING-POINT METHOD. (Faucon, 1910.)

$t^\circ$ of Solid.	Gms. $HCOOH$ per 100 Gms. Mixture.	$t^\circ$ of Solidif.	Gms. $HCOOH$ per 100 Gms. Mixture.	$t^\circ$ of Solidif.	Gms. $HCOOH$ per 100 Gms. Mixture.
0	0	–30	53	–40	74.2
–5	12.5	–35	57.6	–30	79
–10	23	–40	62.5	–20	84.2
–15	32	–45	66.5	–10	89.4
–20	39.2	–49 Eutec.	70	0	95
–25	46.5	–45	71.7	+8.51	100

Similar data for mixtures of 97.4% formic acid and water are given by Kremann, 1907.



## FORMIC ACID

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### DISTRIBUTION OF FORMIC ACID BETWEEN WATER AND BENZENE AT 13-1° (v. Georgievics, 1913.)

A small separatory funnel was used and the acid in each layer titrated with  $\frac{N}{10}$  NaOH, using phenolphthaleine as indicator.

Gms. HCOOH Found per:		Gms. HCOOH Found per:	
25 cc. H <sub>2</sub> O Layer.	150 cc. C <sub>6</sub> H <sub>6</sub> Layer.	25 cc. H <sub>2</sub> O Layer.	150 cc. C <sub>6</sub> H <sub>6</sub> Layer.
1.016	0.016	2.365	0.035
1.539	0.031	3.826	0.062
1.800	0.024	5.874	0.114
2.112	0.031	7.836	0.138

The distribution ratio of formic acid between water and benzene was found King and Narracott (1909) to be 1 to 0.0242 at room temp.

Freezing-point lowering data (solubility, see footnote, p. 1) are given for mixtures of formic acid and dimethylpyrone by Kendall, 1914.

### FUMARIC ACID COOH.CH:CH.COOH.

### MALEIC ACID COOH.CH:CH.COOH. (See also p. 398.)

SOLUBILITY IN WATER. (Vaubel, 1899.)

100 gms. water dissolve 0.672 gm. fumaric acid at 165°.

100 gms. water dissolve 50 grams maleic acid at 100°.

Data for the distribution of fumaric acid between water and ether at 25° are given by Chandler, 1908.

### FURFUROL C<sub>4</sub>H<sub>4</sub>OCHO.

SOLUBILITY IN WATER. (Rothmund, 1898.)

Determinations by Synthetic Method, for which see p. 16.

t°.	Gms. C <sub>4</sub> H <sub>4</sub> OCHO per 100 Gms.		t°.	Gms. C <sub>4</sub> H <sub>4</sub> OCHO per 100 Gms.	
	Aq. Layer.	Furfural Layer.		Aq. Layer.	Furfural Layer.
40	8.2	93.7	100	18.9	83.5
50	8.6	93	110	24	78.5
60	9.2	92	115	28	74.6
70	10.8	90.7	120	34.4	68.1
80	13	89	122.7 (crit. t.) 51		
90	15.5	86.6			

### GADOLINIUM Cobalti **CYANIDE** Gd<sub>2</sub>(CoC<sub>6</sub>N<sub>6</sub>)<sub>3</sub>.9H<sub>2</sub>O.

1000 gms. aq. 10% hydrochloric acid dissolve 1.86 gms. of the salt at 25°. (James and Willard, 191)

### GADOLINIUM GLYCOLATE Gd<sub>2</sub>(C<sub>2</sub>H<sub>3</sub>O<sub>3</sub>)<sub>3</sub>.2H<sub>2</sub>O.

1000 cc. H<sub>2</sub>O dissolve 14.147 gms. of the salt at 20°. (Jantsch and Grünkrant, 1912-13.)

### GADOLINIUM Magnesium **NITRATE**, etc.

SOLUBILITY OF DOUBLE NITRATES OF GADOLINIUM AND OTHER METALS IN CON

NITRIC ACID OF  $d_{4} = 1.325$  (=51.59 GM. HNO<sub>3</sub> PER 100 CC.) at 16°. (Jantsch, 1912.)

Salt.	Formula.	Gms. Hydrat Salt per Lit Sat. Solution
Gadolinium Magnesium Nitrate	[Gd(NO <sub>3</sub> ) <sub>3</sub> ] <sub>2</sub> Mg <sub>3</sub> .24H <sub>2</sub> O	352.3
" Nickel	" Ni <sub>3</sub> "	400.8
" Cobalt	" Co <sub>3</sub> "	451.4
" Zinc	" Zn <sub>3</sub> "	472.7

### GADOLINIUM OXALATE Gd<sub>2</sub>(C<sub>2</sub>O<sub>4</sub>)<sub>3</sub>.10H<sub>2</sub>O.

SOLUBILITY IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 25°. (Wirth, 1913.)

Normality of Aq. H <sub>2</sub> SO <sub>4</sub> .	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	Gd <sub>2</sub> O <sub>3</sub> .	Gd <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> .	
2.16	0.1883	0.3005	Gd <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> .10H <sub>2</sub> O
3.11	0.3010	0.4803	"
4.32	0.4359	0.6956	"
6.175	0.707	1.128	"



SOLUBILITY OF GADOLINIUM OXALATE IN AQUEOUS 20% SOLUTIONS OF METHYLAMINE OXALATE, ETHYLAMINE OXALATE AND TRIETHYLAMINE OXALATE. (Grant and James, 1917.)

Solvent.	Gms. $Gd_2(C_2O_4)_3$ per 100 cc. Solvent.
Aq. 20% Methylamine Oxalate	0.069
" Ethylamine "	0.360
" Triethylamine "	0.883

**GADOLINIUM Dimethyl PHOSPHATE**  $Gd_2[(CH_3)_2PO_4]_3$ .

100 gms.  $H_2O$  dissolve 23 gms.  $Gd_2[(CH_3)_2PO_4]_3$  at 25° and 6.7 gms. at 95°. (Morgan and James, 1914.)

**GADOLINIUM SULFATE**  $Gd_2(SO_4)_3 \cdot 8H_2O$ .

SOLUBILITY IN WATER. (Benedicks, 1900.)

t°.	Gms. $Gd_2(SO_4)_3$ per 100 Gms. $H_2O$ .	Solid Phase.
0	3.98	$Gd_2(SO_4)_3 \cdot 8H_2O$
10	3.3	"
14	2.8	"
25	2.4	"
34.4	2.26	"

SOLUBILITY OF GADOLINIUM SULFATE IN AQUEOUS SOLUTIONS OF:

Sodium Sulfate at 25°. (Bissell and James, 1916.)		Sulfuric Acid at 25°. (Wirth, 1912.)	
Gms. per 100 Gms. $H_2O$ .	Solid Phase.	Normality of $H_2SO_4$ .	Gms. per 100 Gms. Sat. Sol. $Gd_2O_3 = Gd_2(SO_4)_3$ .
0	$Gd_2(SO_4)_3 \cdot 8H_2O$	0	1.793
0.43	"	0.1	1.98
0.47	$Gd_2(SO_4)_3 \cdot Na_2SO_4 \cdot 2H_2O$	0.505	2.365
1.26	"	1.1	2.29
3.01	"	2.16	1.789
7.46	"	6.175	0.528
27.40	"	12.6	0.0521

**GADOLINIUM SULFONATES.**

SOLUBILITY IN WATER.

Salt.	Formula.	t°.	Gms. Anhydrous Salt per 100 Gms. $H_2O$ .	Authority.
Gadolinium $\alpha$ -Nitrobenzene Sulfonate	$Gd[C_6H_4(NO_2)SO_3]_3 \cdot 7H_2O$	15	43.8	(Holmberg, 1907.)
Gadolinium Bromonitrobenzene Sulfonate	$Gd[C_6H_4Br(NO_2)SO_3(1.4.2)]_3 \cdot 10H_2O$	25	6.31	(Katz and James, 1913.)

**GALACTOSE**  $C_6H_{12}O_6$ . See also Sugars, pages 695-7.

100 gms. saturated solution in pyridine contain 5.45 gms.  $C_6H_{12}O_6$  at 26°, density of solution = 1.0065. (Holty, 1905.)

100 gms.  $H_2O$  dissolve 68.3 gms. galactose at 20-25°. (Dehn, 1917.)

100 gms. aq. 50% pyridine dissolve 6.83 gms. galactose at 20-25°. "

**GALLIC ACID** 3,4,5, (OH) $_3C_6H_2COOH \cdot H_2O$ .

SOLUBILITY IN AQUEOUS ETHYL ALCOHOL AT 25°.

(Seidell, 1910.)

Wt. Per Cent $C_2H_5OH$ in Solvent.	$d_m$ of Sat. Sol.	Gms. $C_6H_2(OH)_3COOH \cdot H_2O$ per 100 Gms. Sat. Sol.	Wt. Per Cent $C_2H_5OH$ in Solvent.	$d_m$ of Sat. Sol.	Gms. $C_6H_2(OH)_3COOH \cdot H_2O$ per 100 Gms. Sat. Sol.
0	1.002	1.15	60	0.957	16
10	0.992	2	70	0.946	18
20	0.983	4.2	80	0.933	19.9
30	0.977	7.5	90	0.919	21.2
40	0.972	10.6	95	0.911	21.6
50	0.965	13.4	100	0.902	22.2

100 gms.  $H_2O$  dissolve 0.95 gm. gallic acid at 15°.

100 gms.  $H_2O$  dissolve 33.3 gms. gallic acid at 100°.

(Greenish and Smith, 1903.)

(U. S. P. VIII)



## GALLIC ACID

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### SOLUBILITY OF GALLIC ACID IN ORGANIC SOLVENTS AT 25° (Seidell, 1910.)

Solvent.	Density of Solvent.	$d_{25}$ of Sat. Solution.	Gms. COOH per 100 Gms. Solvent.
Acetone	$d_{15} = 0.797$	0.941	25
Amyl alcohol (iso)	$d_{20} = 0.817$	0.834	5
Amylacetate	$d_{20} = 0.875$	0.878	2
Benzene	$d_{25} = 0.873$	0.875	0
Carbon Disulfide	$d_{25} = 1.258$	1.262	0
Ether (abs.)	$d_{20} = 0.711$	0.718	1
Ethylacetate	$d_{25} = 0.892$	0.911	3.6

The amount of gallic acid dissolved by carbon tetrachloride, chloroform, or toluene was too small for estimation.

100 gms. glycerol dissolve 8.3 gms.  $C_6H_3(OH)_3COOH \cdot H_2O$  at 25°. (U. S. P.)

100 gms. 95% formic acid dissolve 0.56 gm. gallic acid at 19.4°. (Aschaz)

### GERMANIUM DIOXIDE $GeO_2$ .

100 gms.  $H_2O$  dissolve 0.405 gm.  $GeO_2$  at 20°, and 1.07 gms. at 100°. (Winkl)

### GERMANIUM (Mono) SULFIDE $GeS$

### GERMANIUM (Di) SULFIDE $GeS_2$ .

100 gms.  $H_2O$  dissolve 0.24 gm.  $GeS$

100 gms.  $H_2O$  dissolve 0.45 gm.  $GeS_2$ .

(Winkl)

### GLASS.

For data on the solubility of glass in water and other solvents, see:

(Cowper, 1882; Emmerling, 1869; Böbling, 1884; Kreusler and Herzhold, 1884; Kohlraus Förster, 1892; Mylius and Förster, 1889; 1892; Wartha, 1885; Nicolardot, 1916.)

### GLOBULIN (Serum).

#### SOLUBILITY IN AQUEOUS MAGNESIUM SULFATE SOLUTIONS.

(Galeotti, 1906; Scaffidi, 1907.)

The precipitated globulin (from oxblood) was not dried, but pressed t filter paper, and an excess introduced into each  $MgSO_4$  solution. After c agitation for 12 hours, the saturated solution was filtered, weighed and eva to constant weight, the coagulated globulin then washed to disappearance and dried and weighed.

Results for 10°.		Results for 25°.		Results for 40°.		Results for 55°.		Results f
Gms. per 100 Sat. Sol.	Gms. Globulin.	Gms. per 100 Sat. Sol.	Gms. Globulin.	Gms. per 100 Sat. Sol.	Gms. Globulin.	Gms. per 100 Sat. Sol.	Gms. Globulin.	Gms. per 100 Sat. Sol.
0.06	0.07	0.06	0.07	0.06	0.42	0.40	1.14	0.71
0.18	0.34	0.21	0.61	0.31	1.42	0.88	2.14	2.52
0.65	1.63	0.63	2.20	0.61	5.39	1.60	3.34	4.74
2.11	3.35	2.28	5.56	1.92	8.31	5.64	5.06	6.83
4.32	4.42	3.35	6.07	5.40	8.63	10.81	3.10	9.22
13.63	2.60	16	4.03	14.72	3	13.84	2.11	13.29
20.86	0.37	21.30	0.95	18.47	1.02	17.90	0.69	15.38
24.18	0.18	25.47	0.03	27.03	0.01			17.67

The coagulation curve and freezing-point curve are also given.

### GLUCOSE $d$ $C_6H_{12}O_6 \cdot H_2O$ . See also Sugars, pages 695-7.

100 gms. $H_2O$	dissolve 82	gms. glucose at 20-25°.	(Del
100 gms. pyridine	" 7.62	" " "	"
100 gms. aq. 50% pyridine	" 49.17	" " "	"
100 gms. trichlor ethylene	" 0.006	" " "	15°

(Wester and Bruhl)

### GLUTAMINIC ACID $C_5H_9NH_2(COOH)_2$ .

Data for the solubility of glutaminic acid in aq. salt solutions are gi Würgler (1914) and Pfeiffer and Würgler (1916).



**GLUTAMINIC ACID HYDROCHLORIDE**  $C_5H_9NH_2(COOH)_2 \cdot HCl$ .

SOLUBILITY IN WATER. (Stoltzenberg, 1912.)

(The following results were taken from the diagram given by the author.)

t°.	Gms. Glutaminic Acid. HCl per 100 cc. Sat. Sol.	t°.	Gms. Glutaminic Acid. HCl per 100 cc. Sat. Sol.
0	31.5	60	57
10	34.5	70	62
20	38	80	67.5
30	42.5	90	74
40	47	100	81
50	52	20	1.4 (sol. sat. with HCl)

**GLUTARIC ACID** (Pyrotartaric)  $(CH_2)_3(COOH)_2$ .

SOLUBILITY IN WATER. (Lamoureux, 1899)

t°.	0°.	15°.	20°.	35°.	50°.	65°.
Gms. $(CH_2)_3(COOH)_2$ per 100 cc. solution	42.9	58.7	63.9	79.7	95.7	111.8

100 gms. 95% formic acid dissolve 55.62 gms. glutaric acid at 18.6°. (Aschan, 1913.)  
Data for the distribution of glutaric acid between water and ether at 25° are given by Chandler, 1908.

F. pt. data for glutaric acid + sulfuric acid.

(Kendall and Carpenter, 1914.)

**GLYCINE** (Glycocol)  $CH_2NH_2COOH$ .100 gms.  $H_2O$  dissolve 51 gms.  $CH_2NH_2COOH$  at 20-25°. (Dehn, 1917.)100 gms. pyridine dissolve 0.61 gm.  $CH_2NH_2COOH$  at 20-25°. "100 gms. aq. 50% pyridine dissolve 0.74 gm.  $CH_2NH_2COOH$  at 20-25°. "

SOLUBILITY OF GLYCINE IN WATER AND IN Aq. SALT SOLUTIONS AT 20°.

(Pfeiffer and Würgler, 1915, 1916.)

Salt.	Mols. Salt per Liter.	Gms. Glycine per 10 cc. Sat. Sol.	Salt.	Mols. Salt per Liter.	Gms. Glycine per 10 cc. Sat. Sol.
Water only		1.962	LiCl	0.96	4.188
BaCl <sub>2</sub>	0.5	2.375	LiBr	0.97	4.245
BaBr <sub>2</sub>	0.5	2.954	SrCl <sub>2</sub>	0.25	2.129
SrCl <sub>2</sub>	0.5	2.362	"	0.50	2.331
SrBr <sub>2</sub>	0.49	2.440	"	1	2.605
CaCl <sub>2</sub>	0.57	4.848	"	2	3.301
CaBr <sub>2</sub>	0.51	4.994			

10 cc. sat. aq. solution contains 1.8 gms. glycine + 2.7 gms. KCl at 20° when both are present in the solid phase.

(Pfeiffer and Modelski, 1912.)

**GLYCOLIC ACID**  $CH_2OHCOOH$ .

SOLUBILITY IN WATER. (Emich, 1884.)

t°.	20°.	60°.	80°.	100°.
Gms. $CH_2OH(COOH)$ per 100 gms. $H_2O$	0.033	0.102	0.235	0.850

Phenyl**GLYCOLIC ACID** dextro and racemic.  $CH_2C_6H_5.OH.COOH$ .

SOLUBILITY OF DEXTRO AND OF RACEMIC PHENYL GLYCOLIC ACID IN CHLOROFORM. (Holleman, 1898.)

t°.	Gms. Dextro Acid per 100 Gms. $CHCl_3$ .	t°.	Gms. Racemic Acid per 100 Gms. $CHCl_3$ .
15	0.952	15	0.877
25	1.328	25	1.07
35	1.950	35	1.60

**GLYCYRRHIZIC ACID.**100 gms. sat. solution in  $H_2O$  contain 0.575 gm. glycyrrhizic acid at 15°. (Capin, '12.)100 gms. sat. solution in  $H_2O$  contain 0.152 gm. Am. glycyrrhizate at 0° and 0.225 gm. at 15°. i

(Capin, 1912.)

Phenyl**GLYOXAL** Phenyl hydrazone  $C_6H_5.CO.CH.N.NH.C_6H_5$ .One liter  $C_6H_6$  dissolves 52.6 gms. of the A form at 5°.

(Sidgwick, 1915)

One liter  $C_6H_6$  dissolves 2.9 gms. of the B form at 5°.

"



**GOLD Au.****SOLUBILITY OF GOLD IN POTASSIUM CYANIDE SOLUTIONS.** (Mackenzie, <sup>1</sup>)

Gold disks were placed in Nessler tubes with aqueous KCN solutions.

Gms. Au Dissolved in 24 Hours in Nessler Tubes:

Per cent KCN.	Full.	$\frac{1}{2}$ Full.	Oxygen Passed in.	Oxygen + Agitation.
0.1	0.00195	0.00331	...	...
1	0.00162	0.00418	0.00845	0.0187
5	0.0032	0.0046	0.01355	0.0472
20	0.0012	0.00305	0.0115	0.0314
50	0.00043	0.00026	0.00505	0.0108

The following data for more dilute KCN solutions are given by Christy (1) Gold strips  $2 \times \frac{1}{2}$  inch were rotated for 24 hrs. in aq. KCN solutions and loss in weight determined.

Per cent KCN.	Mgs. Au Dissolved.	Per cent KCN.	Mgs. Au Dissolved.	Per cent KCN.	Mgs. Diss.
0	0.010	0.002	0.44	0.016	74
0.0005	0.043-0.07	0.00325	1.77	0.0325	150
0.001	0.10-0.23	0.004	4.29	0.065	168
0.0016	0.16	0.008	48.43		

Data are also given for 48 hour periods and for solutions containing  $O_2$ .One liter of conc.  $HNO_3$  dissolve 0.66 gm. Au on boiling for two hours. (Dewey)

Data for the rate and limit of solubility of Au in conc. HCl solutions of alum and of cupric chloride are given by McCaughey, 1909.

**GOLD CHLORIDE (Auric)  $AuCl_3$ .**100 gms.  $H_2O$  dissolve 68 gms.  $AuCl_3$ .

When 1 gm. of gold as chloride is dissolved in aq. HCl of different strength the solutions shaken with 100 cc. portions of ether, the following percentage the gold enter the ethereal layer. With 20% HCl, 95%; 10% HCl, 98%; 5% 98%; 1% HCl, 84% and 0.18% HCl, 40.3% of the gold.

Distribution results, indicating considerable variation in the constitution of dissolved substance in the two layers, are also given. (Mylius)

**GOLD PHOSPHORUS TRI CHLORIDE (Aurous)  $AuClPCl_2$ .**100 gms.  $PCl_3$  dissolve 1 gram at  $15^\circ$ , and about 12.5 grams at 1

(Lindet — Compt. rend. 101, 149)

**GOLD ALKALI DOUBLE CHLORIDES.****SOLUBILITY OF SODIUM GOLD CHLORIDE, LITHIUM GOLD CHLORIDE,**

POTASSIUM GOLD CHLORIDE, RUBIDIUM GOLD CHLORIDE,

CAESIUM GOLD CHLORIDE IN WATER.

(Rosenbladt — Ber. 19, 2537, '86.)

Grams Anhydrous Salt per 100 Grams Solution.

$t^\circ$ .	$NaAuCl_4$ .	$LiAuCl_4$ .	$KAuCl_4$ .	$RbAuCl_4$ .	$CsAuCl_4$ .
10	58.2	53.1	27.7	4.6	0.5
20	60.2	57.7	38.2	9.0	0.8
30	64.0	62.5	48.7	13.4	1.7
40	69.4	67.3	59.2	17.7	3.2
50	77.5	72.0	70.0	22.2	5.4
60	90.0	76.4	80.2	26.6	8.2
70	...	81.0	...	31.0	12.0
80	...	85.7	...	35.3	16.3
90	...	...	...	39.7	21.7
100	...	...	...	44.2	27.5

100 gms. glycerol ( $d_{16} = 1.256$ ) dissolve 0.21 gm.  $AuK(CN)_2 \cdot 5H_2O$  at  $15^\circ$ 

(Ossendowski)



**GUAIACOL**  $C_8H_8(OH)OCH_3$ .**GUAIACOL CARBONATE**  $[C_8H_8(OCH_3)O]_2CO$ .

## SOLUBILITY IN WATER, ALCOHOL, ETC. (U. S. P. VIII.)

Solvent.	t°.	Gms. per 100 Gms. Solvent.	
		Guaiacol.	Guaiacol Carbonate.
Water	25	1.89	...
Alcohol	25	...	2.08
Chloroform	25	...	66.6
Ether	25	...	7.69
Glycerol	25	100	...

The coefficient of distribution of guaiacol carbonate between olive oil and water at 25° is given as  $\frac{S_{oil}}{S_w} = 3.7$  by Boeseken and Waterman, 1911, 1912.

Freezing-point lowering data (solubility, see footnote, p. 1) are given for mixtures of guaiacol and  $\alpha$  naphthylamine by Pushin and Mazarovic, 1914; for mixtures of guaiacol and picric acid by Philip and Smith, 1905; and for mixtures of guaiacol and salol by Bellucci, 1912, 1913.

**Tri PhenylGUANIDINE**  $C_6H_5N:C(NHC_6H_5)_2$ .

## SOLUBILITY IN MIXTURES OF ALCOHOL AND WATER AT 25°. (Holleman and Antusch, '94.)

Vol. % Alcohol.	Gms. $C_6H_5N:C(NHC_6H_5)_2$ per 100 Gms. Solvent.	Density of Solutions.	Vol. % Alcohol.	Gms. $C_6H_5N:C(NHC_6H_5)_2$ per 100 Gms. Solvent.	Density of Solutions.
100	6.23	0.8021	80	1.06	0.8572
95	3.75	0.8158	75	0.67	0.8704
90	2.38	0.8309	70	0.48	0.8828
85	1.58	0.8433	60	0.22	0.9048

See remarks under  $\alpha$  Acetnaphthalide, p. 13.

Freezing-point lowering data for mixtures of triphenylguanidine and triphenyl methane and for triphenylguanidine and phthalide are given by Lautz, 1913.

**HEMOGLOBIN.**

100 gms. H <sub>2</sub> O dissolve 15.16 gms. hemoglobin at 20-25°.	(Dehn, 1917.)
100 gms. pyridine dissolve 0.15 gm. hemoglobin at 20-25°.	"
100 gms. aq. 50% pyridine dissolve 0.77 gms. hemoglobin at 20-25°.	"

**HELIANTHIN** (Methyl Orange, Tropaeolin).

100 cc. H <sub>2</sub> O dissolve 0.0055 to 0.0225 gm. helianthin.	(Dehn, 1917a.)
100 cc. pyridine dissolve 0.75 gm. helianthin.	"
100 cc. 50% aq. pyridine dissolve 62.5 gms. helianthin.	"

Results for other solvents and observations on the state of colored compounds in solution are given.

**HELIUM** He.

## SOLUBILITY IN WATER. (von Antropoff, 1909-10.)

t°.	Coef. of Absorption.
0	0.0134
10	0.0100
20	0.0138
30	0.0161
40	0.0191
50	0.0226

The coef. of absorption adopted for the present results is that of Bunsen as modified by Kuenen. The modification consists in substituting unit of mass in place of unit of volume of water, in the formula.



## HELIUM He.

SOLUBILITY IN WATER.  
(Estreicher — Z. physik. Chem. 31, 184, '99.)

t°.	Cor. Barometric Pressure.	Vol. of Water.	Vol. of He.	g.	Absorption Coefficient	
					At Bar. Pressure Minus H <sub>2</sub> O Vapor Tension.	At 760 mm Pressure.
0	...	...	...	0.000270	...	0.015
0.5	764.0	73.584	1.093	...	0.0149	0.014
5	758.0	73.578	1.062	0.000260	0.0144	0.014
10	758.0	73.597	1.046	0.000255	0.0142	0.0144
15	757.8	73.641	1.008	0.000246	0.0137	0.0140
20	758.4	73.707	0.996	0.000242	0.0135	0.0139
25	762.3	73.793	0.983	0.000238	0.0133	0.0137
30	764.4	73.897	0.985	0.000238	0.0133	0.0138
35	764.5	74.0167	0.972	0.000234	0.0131	0.0138
40	762.0	74.147	0.957	0.000232	0.0129	0.0139
45	761.7	74.294	0.947	0.000229	0.0127	0.0140
50	760.9	74.461	0.920	0.000223	0.0124	0.0140

For  $q$  and also absorption coefficient, see Ethane, p. 285.

**HEPTANE**  $n$   $\text{CH}_3(\text{CH}_2)_5\text{CH}_3$ .

F.-pt. lowering data for mixtures of heptane and phenol are given by (Carn and Delgrosso, 1913).

**HEPTOIC ACID**  $\text{CH}_3(\text{CH}_2)_5\text{COOH}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 0.241 gm. heptoic acid at 15°. (Lumsden, 1)

**HEXAMETHYLENE** (Hexahydrobenzene). See Cyclohexane, p. 280.**HEXAMETHYLENE TETRAMINE**  $(\text{CH}_2)_6\text{N}_4$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 81.32 gms.  $(\text{CH}_2)_6\text{N}_4$  at 12°. (Delepine, 1)

100 gms. abs. alcohol dissolve 3.22 gms.  $(\text{CH}_2)_6\text{N}_4$  at 12°. "

100 cc. 90% alcohol dissolve 12.5 gms.  $(\text{CH}_2)_6\text{N}_4$  at 15–20°. (Squire and Cairnes, 1)

100 gms.  $\text{CHCl}_3$  dissolve 8.09 gms.  $(\text{CH}_2)_6\text{N}_4$  at 12°. (Delepine, 1)

**HEXANE**  $\text{C}_6\text{H}_{14}$ .

## SOLUBILITY IN METHYL ALCOHOL.

(Rothmund, 1898.)

Determined by synthetic method, see p. 16.

t°.	Gms. Hexane per 100 Gms.		t°.	Gms. Hexane per 100 Gms.	
	Alcoholic Layer.	Hexane Layer.		Alcoholic Layer.	Hexane Layer.
10	26.5	96.8	35	43.6	91.2
20	31.6	95.9	40	52.7	85.5
30	38.3	93.7	42.6 (crit. t.)	68.9	

F.-pt. data for hexane + phenol.

(Campetti and Delgrosso, 1)

**HIPPURIC ACID**  $\text{C}_6\text{H}_5\text{CO.NH.CH}_2\text{COOH}$ .

## SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. $\text{C}_6\text{H}_5\text{CO.NH.CH}_2\text{COOH}$ per 100 Gms. Solvent.		Authorit.
Water	20–25	0.42		(Dehn, 1917.
Methyl Alcohol	22	9.80		(Timofeiew, 1
Ethyl Alcohol	22	5.20		"
Propyl Alcohol	23	2.80		"
50% Aqueous Pyridine	20–25	88		(Dehn, 1917.



## SOLUBILITY OF HIPPURIC ACID AT 25° IN AQUEOUS SOLUTIONS OF:

Formic Acid. (Kendall, 1911.)			Sodium Hippurate. (Sidgwick, 1910.)		
Normality of Aq. HCOOH.	Gms. Hippuric Acid per Liter.	Normality of Aq. HCOOH.	Gms. Hippuric Acid per Liter.	Normality of Aq. Sodium Hippurate.	Gms. Hippuric Acid per Liter.
	3.67	5	4.08	0	6.99(?)
0.25	3.61	10	4.77	1	13.97(?)
0.5	3.72				

HIPPURIC ACID  $C_9H_7CONH.CH_2COOH$ .SOLUBILITY IN Aq. POTASSIUM HIPPURATE SOLUTIONS AT 20°.  
(Hoitsema — Z. physik. Chem. 27, 317, '98.)

Density of Solutions.	Gram Mols. per Liter Sol.		Grams per Liter Solution.		Solid Phase.
	$C_9H_7NO_2$	$KC_9H_7NO_2$	$C_9H_7NO_2$	$KC_9H_7NO_2$	
1.002	0.0182	0	3.276	0.0	$C_9H_7NO_2$
1.003	0.0163	0.011	2.919	2.39	"
1.008	0.0183	0.071	3.278	15.43	"
1.022	0.0234	0.254	4.191	55.18	"
1.114	0.064	1.36	11.47	295.4	"
1.182	0.131	2.21	23.46	480.1	"
1.192	0.147	2.32	26.32	504.1	$C_9H_7NO_2 + C_9H_7NO_2.KC_9H_7NO_2.H_2O$
1.195	0.153	2.40	27.40	521.4	
1.201	0.133	2.50	23.82	543.1	$C_9H_7NO_2.KC_9H_7NO_2.H_2O$
1.239	0.084	3.01	15.04	654.0	"
1.282	0.068	3.57	12.18	775.7	$C_9H_7NO_2.KC_9H_7NO_2.H_2O + KC_9H_7NO_2$
1.282	0.065	3.58	11.60	777.8	
1.276	0.031	3.56	5.55	773.4	$KC_9H_7NO_2$
1.277	0.011	3.55	1.917	771.3	"
1.277	0.00	3.56	...	773.4	"

## HOLOCAINE HYDROCHLORIDE.

100 gms.  $H_2O$  dissolve 2 gms. holocaine hydrochloride at 15–20°.

(Squire and Caines, 1905.)

BOMATROPINE HYDROBROMIDE  $C_{16}H_{21}NO_3.HBr$ .

## SOLUBILITY IN WATER, ETC.

(U. S. P. VIII.)

100 gms. water dissolve 17.5 gms. salt at 25°.

100 gms. alcohol dissolve 3.08 gms. salt at 25°, and 11.5 gms. at 60°.

100 gms. chloroform dissolve 0.16 gm. salt at 25°.

HYDRASTINE  $C_{21}H_{21}NO_4$ . HYDRASTININE HYDROCHLORIDE  $C_{11}H_{11}NO_3.HCl$ .

## SOLUBILITY IN SEVERAL SOLVENTS.

(U. S. P. VIII; at 18°–22°, Müller, 1903.)

Solvent.	Gms. $C_{21}H_{21}NO_4$ per 100 Gms. Solution.		Solvent.	Gms. per 100 Gms. Solution at 18°–22°.	
	At 18°–22°.	At 80°.		$C_{21}H_{21}NO_4$ .	$C_{11}H_{11}NO_3.HCl$ .
Water	0.033	0.025	Ether	0.51	0.078 (25°)
Alcohol	0.74 (25°)	5.9 (60°)	Ether + $H_2O$	0.80	...
Benzene	8.89	...	Chloroform	100+	0.35 (25°)
Ethyl Acetate	4.05	...	$CCl_4$	0.123	...
Petroleum Ether	0.073				



**HYDRAZIDES.**

SOLUBILITY OF THE TAUTOMERIC FORMS OF HYDRAZIDES IN BENZENE AT 5°  
Determined by the freezing-point method. See also p. 487. (Sidgwick, 1935)

Compound.	Formula.	Gms. Compound Dissolved per Liter Benzene
Phthalylphenylhydrazide	$C_6H_4 \begin{Bmatrix} CO \\ CO \end{Bmatrix} N.NH.C_6H_5$	$\left. \begin{array}{l} A \text{ form } 5.5 \\ C \text{ form } 1.1 \end{array} \right\}$
Phthalylphenylmethylhydrazide	$C_6H_4 \begin{Bmatrix} CO \\ CO \end{Bmatrix} N.N(CH_3)C_6H_5$	$A \text{ form } 124$

**HYDRAZINE  $NH_2.NH_2$ .**

DISTRIBUTION OF HYDRAZINE BETWEEN WATER AND BENZENE.  
(Georgievics, 1915.)

Gms. $NH_2.NH_2$ per:		Gms. $NH_2.NH_2$ per:	
25 cc. $H_2O$ Layer.	75 cc. $C_6H_6$ Layer.	25 cc. $H_2O$ Layer.	75 cc. $C_6H_6$ Layer.
0.4137	0.027	1.7601	0.0626
0.6676	0.0335	2.3336	0.1101
1.0862	0.0355	4.75	0.137

**HYDRAZINE PerCHLORATE  $N_2H_4(HClO_4)_{1.3}H_2O$ .**

SOLUBILITY IN WATER. (Carlson, 1910.)

t°.	Sp. Gr. Sat. Sol.	Gms. $N_2H_4(HClO_4)_{1.3}$ per 100 cc. Sat. Sol.
18	1.264	41.72
35	1.391	66.9

**HYDRAZINE MonoNITRATE  $N_2H_4.HNO_3$ .**

SOLUBILITY IN WATER. (Sommer, 1914.)

t°.	Gms. $N_2H_4.HNO_3$ per 100 Gms.		t°.	Gms. $N_2H_4.HNO_3$ per 100 Gms.	
	Sat. Sol.	Water.		Sat. Sol.	Water.
10	63.63	174.9	40.02	85.86	607.2
15	68.47	217.2	45.02	88.06	737.6
20.01	72.70	266.3	50.01	91.18	1034
25.01	76.61	327.5	55.01	93.58	1458
30.01	80.09	402.2	60.02	95.51	2127
35.01	83.06	490.3			

**HYDRAZINE SULFATE  $N_2H_4.H_2SO_4$ .**

100 grams water dissolve 3.055 gms.  $N_2H_4.H_2SO_4$  at 22°. (Curtius and Jay, 18

Phenyl **HYDRAZINE** and other substituted hydrazines. See page 486.

**HYDRIODIC ACID  $HI$ .**

SOLUBILITY IN WATER, DETERMINED BY FREEZING-POINT METHOD.  
(Pickering, 1893a.)

t°.	Gm. $HI$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $HI$ per 100 Gms. Sat. Sol.	Solid Phase
-10	20.3	Ice	-60	52.6	$HI_4H_2O$
-20	29.3	"	-40	59	"
-30	35.1	"	about -35.5 m. pt.	64	"
-40	39	"	-40	65.5	"
-50	42	"	-49	66.3	" + $HI_3F$
-60	44.4	"	-48 m. pt.	70.3	$HI_3H_2O$
-70	46.2	"	-56	73.5	" + $HI_2E$
-80	47.9	" + $HI_4H_2O$	-52	74	$HI_2H_2O$

F.-pt. data for  $HI + H_2S$  (Bagster, 1911),  $HI + (CH_3)_2O$ . (Maass and McIntosh, 191



## HYDROBROMIC ACID HBr.

## SOLUBILITY IN WATER.

— Z. physik. Chem. 2, 454, '88; Rec. trav. chim. 4, 107, '85; 3, 358, '86; see also Pickering  
— Phil. Mag. [5] 36, 119, '93.)

t°.	Gms. HBr Dissolved (at 760-765 mm.) per 100 Gms.		β.	Gms. HBr Dissolved at Lower Pressures per 100 Gms. H <sub>2</sub> O.
	Water.	Solution.		
-2.5	255.0	71.83	...	175.0 (10 mm.)
-15	239.0	70.50	...	...
0	221.2	68.85	611.6	...
+10	210.3	67.76	581.4	108.5 (5 mm.)
15	204.0	67.10	...	...
25	193.0	65.88	532.1	...
50	171.5	63.16	468.6	...
75	150.5	60.08	406.7	...
100	130.0	56.52	344.6	...

For β see ethane, p. 285.

F.-pt. data for HBr + H<sub>2</sub>S (Bagster, 1911); HBr + (CH<sub>3</sub>)<sub>2</sub>O, HBr + CH<sub>3</sub>OH,  
HBr + C<sub>2</sub>H<sub>5</sub>OH, HBr + CH<sub>3</sub>COOC<sub>2</sub>H<sub>5</sub> and HBr + C<sub>6</sub>H<sub>5</sub>CH<sub>3</sub>.  
(Maass and McIntosh, 1912.) (Reid and McIntosh, 1916.)

## HYDROCHLORIC ACID HCl.

## SOLUBILITY IN WATER BY THE FREEZING-POINT METHOD.

(Composite curve from results of Roloff, 1895; Pickering, 1893(a); Roozeboom,  
1884, 1889 and Rupert, 1909.)

t°.	Gms. HCl per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. HCl per 100 Gms. Sat. Sol.	Solid Phase.
-1.706	1.66	Ice	-18.4	48.6	HCl <sub>2</sub> H <sub>2</sub> O
-14.97	10.02	"	-17.7 m. pt.	50.3	"
-28.84	14.51	"	-18.7	52.85	"
-40	17.40	"	-19.4	54.1	"
-60	21.30	"	-20.8	55.7	"
-80	24.20	"	-21.3	56.5	"
-86 Eutec.	24.8	" + HCl <sub>3</sub> H <sub>2</sub> O	-23.2	57.3	"
-50	30.1	HCl <sub>3</sub> H <sub>2</sub> O	-23.5 Eutec.	...	" + HCl <sub>3</sub> H <sub>2</sub> O
-40	32.7	"	-21.5	58.2	HCl <sub>3</sub> H <sub>2</sub> O
-30	36.5	"	-20.7	59.1	"
-24.9 m. pt.	40.3	"	-18.4	61.1	"
-27.5	44	" + HCl <sub>2</sub> H <sub>2</sub> O	-17.4	62.4	"
-23.8	45.7	HCl <sub>2</sub> H <sub>2</sub> O	-15.4	65.4	"
-21.2	45.9	"	-15.35	66.8	"

At about -15.35 two liquid layers are formed. Data for these are as follows:

HCl layer.				H <sub>2</sub> O layer.			
t° of Saturation	Gms. H <sub>2</sub> O per 100 Gms. Sat. Sol.	t°.	Gms. HCl per 100 Gms. Sat. Sol.	d. of Sat. Sol.	t°.	Gms. HCl per 100 Gms. Sat. Sol.	d. of Sat. Sol.
Below -50	0.008	-20	67.65	1.279	15	64.70	1.231
" -50	0.017	-15	67.29	1.269	20	64.19	1.228
Between -15 and 0°	0.077	-10	66.71	1.260	30	63.21	1.229
Above 45	0.021	-5	66.44	1.255	35	62.90	1.227
"	0.052	0	65.85	1.247	40	62.27	1.218
"	0.11	+5	65.48	1.245	45	61.76	1.212
"	0.13	10	65.18	1.240	50	61.65	1.219

For additional data on this system see Baume and Tykociner, 1914.



# HYDROCHLORIC ACID

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## HYDROCHLORIC ACID HCl.

### SOLUBILITY IN WATER AT DIFFERENT TEMPERATURES AND PRESSURES.

(Deicke; Roscoe and Dittmar — Liebig's Ann. 112, 334, '59; below 0°, Roseboom — Rec. trav. chim. 3, 104, '84.)

t°.	At Different Temperatures and 760 mm. Pressure.				At Different Pressures and t°	
	cc. HCl per 100 cc. H <sub>2</sub> O.	Density.	Gms. HCl per 100 g. Sol.	Gms. HCl per 100 g. H <sub>2</sub> O.	Pressures.*	Gms. HCl per 100 g. H <sub>2</sub> O
0	525.2	1.2257	45.15	82.31	60	61.3
4	497.7	1.2265	44.36	79.73	100	65.7
8	480.3	1.2185	43.83	78.03	150	68.6
12	471.3	1.2148	43.28	76.30	200	70.7
14	462.4	1.2074	42.83	74.92	300	73.8
18	451.2	1.2064	42.34	73.41	400	76.3
23	435.0	1.2014	41.54	71.03	500	78.2
30	...	..	40.23	67.3	600	80.0
40	...	...	38.68	63.3	750	82.4
50	...	...	37.34	59.6	1000	85.6
60	...	...	35.94	56.1	1300	89.5

\* Pressures in mm. Hg minus tension of H<sub>2</sub>O vapor.

### SOLUBILITY IN WATER AT TEMPERATURES BELOW 0°.

At a pressure of 760 mm.				At pressures below and above 760 mm. Pressure.		
t°.	g.	t°.	g.	t°.	mm. Pressure.	g.
-24	101.2	-15	93.3	-23.8	...	84.2
-21	98.3	-10	89.8	-21	334	86.8
-18.3	96	-5	86.8	-19	580	92.6
-18	95.7	0	84.2	-18	900	98.4
				-17.7	1073	101.4

For definition of g, see Ethane, p. 285.

The eutectic is at -86° and 33 gms. HCl per 100 gms. H<sub>2</sub>O.

### SOLUBILITY OF HYDROCHLORIC ACID GAS IN METHYL ALCOHOL, ETHYL ALCOHOL, AND IN ETHER AT 760 MM. PRESSURE.

(de Bruyn — Rec. trav. chim. 11, 129, '92; Schuncke — Z. physik. Chem. 14, 336, '94.)

t°.	Grams HCl gas per 100 Grams Solution in:		
	CH <sub>3</sub> OH.	C <sub>2</sub> H <sub>5</sub> OH.	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.
-10	54.6	...	37.51 (-9.2°)
-5	...	...	37.0
0	51.3	45.4	35.6
+5	...	44.2 (6.5°)	33.1
10	...	42.7 (11.5°)	30.35
15	...	...	27.62
20	47.0 (18°)	41.0	24.9
25	...	40.2 (23.5°)	22.18
30	43.0 (31.7°)	38.1 (32°)	19.47



**SOLUBILITY OF HYDROCHLORIC ACID GAS IN AQ. SULFURIC ACID SOLUTIONS.**  
(Coppadoro, 1909.)

Results at 17°.			Results at 40°.			Results at 70°.		
Gd Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Gd of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Gd of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.	
	H <sub>2</sub> SO <sub>4</sub> .	HCl.		H <sub>2</sub> SO <sub>4</sub> .	HCl.		H <sub>2</sub> SO <sub>4</sub> .	HCl.
1.111	0	42.7	1.185	3.56	35.6	1.145	1.61	32.7
1.120	1.86	39.9	1.195	5.86	34.8	1.150	3.38	31.1
1.120	4.75	39.2	1.210	8.90	32.4	1.160	4.80	30.5
1.135	8.04	36.9	1.255	16.80	27.6	1.180	7.93	28.9
1.160	12.80	33.2	1.255	18.8	25.9	1.225	18.9	22.8
1.195	20.9	28.5	1.340	28.6	18.5	1.230	20	22.3
1.155	30.8	22.6	1.400	44.2	11.5	1.315	36.2	13.2
1.130	44.6	15	1.520	61.1	3.35	1.380	48	6.99
1.145	59.4	6.26	1.575	66.4	1.17	1.510	62.7	1.56
1.180	65.4	3.25	1.650	73.2	0.17	1.560	67.6	0.54
1.660	73.7	0.62	1.725	79.4	0.081	1.700	80.7	0.05
1.735	77.5	0.11	1.755	81.4	0.032	1.745	83	0.035
1.815	89	0.068	1.770	83.5	0.029	1.745	83.4	0.032

**MISCIBILITY OF HYDROCHLORIC ACID WITH MIXTURES OF WATER AND PHENOL AT 12°.**

(Schreinemakers and van der Horn van der Bos, 1912.)

Composition of the Reciprocally Saturated Liquid Pairs.				Composition of the Solutions in Contact with Solid Phenol.		
Water Rich Layer.		Phenol Rich Layer.				
% HCl.	% Phenol.	% HCl.	% Phenol.	% Water.	% HCl.	% Phenol.
0	7.45	0	72	11.22	0	88.78
3.1	6.6	0.09	78	84.5	10.7	4.8
6.6	5.3	0.2	80.3	80.38	15.64	3.98
8	5.1	0.36	82.6	72.43	24.37	3.2
10.7	4.8	0.52	84.5	60.25	36.25	3.5

Additional data for this system are given by Krug and Cameron, 1900.

**FREEZING-POINT DATA (Solubility, see footnote, p. 1) FOR MIXTURES OF HYDROCHLORIC ACID AND OTHER COMPOUNDS.**

Hydrochloric Acid	+ Hydrogen Sulfide	(Baume and Georgitses, 1912, 1914.)
"	+ Methyl Alcohol	{ (Baume and Borowski, 1914; Baume and Pamfil, 1911, 1914; Maass and McIntosh, 1913.)
"	+ Methyl Chloride	(Baume and Tykociner, 1914.)
"	+ Methyl Ether	(Maass and McIntosh, 1912; Baume, 1911, 1914.)
"	+ Propionic Acid	(Baume and Georgitses, 1912, 1914.)
"	+ Sulfur Dioxide	(Baume and Pamfil, 1911, 1914.)

**HYDROCYANIC ACID HCN.**

**DISTRIBUTION BETWEEN WATER AND BENZENE.**  
(Hantzsch and Sebalt, 1899; Hantzsch and Vagt, 1901.)

°.	Mol. HCN per Liter:			°.	Mol. HCN per Liter:		
	H <sub>2</sub> O Layer (c).	C <sub>6</sub> H <sub>6</sub> Layer (c').	c/c'		H <sub>2</sub> O Layer (c).	C <sub>6</sub> H <sub>6</sub> Layer (c').	c/c'
6	0.00625	0.00325	1.923	7	0.0574	0.0148	3.88
16	0.00593	0.00363	1.634	20	0.0572	0.0154	3.72
25	0.00580	0.00375	1.547				

Data for the effect of HCl and of KCl on the distribution are also given.

**HYDROFLUORIC ACID HF.**

100 grams H<sub>2</sub>O dissolve 111 grams HF at -35°.

(Metzner, 1894.)



## HYDROGEN H.

## SOLUBILITY IN WATER.

(Winkler — Ber. 24, 99, '91; Bohr and Bock — Wied. Ann. 44, 318, '91; Timofejew — Z. phys. Chem. 6, 147, '90.)

t°.	$\beta'$ .	$l$ .		$\beta$ .	$g$ .
0	0.0214	...	...	0.0214	0.000 <b>93</b>
5	0.0203	0.0209	— 0.0241	0.0204	0.000 <b>84</b>
10	0.0193	0.0204	— 0.0229	0.0195	0.000 <b>76</b>
15	0.0185	0.0200	— 0.0217	0.0188	0.000 <b>69</b>
20	0.0178	0.0196	— 0.0205	0.0182	0.000 <b>62</b>
25	0.0171	0.0193	— 0.0191	0.0175	0.000 <b>56</b>
30	0.0163	...	...	0.0170	0.000 <b>47</b>
40	0.0153	...	...	0.0164	0.000 <b>39</b>
50	0.0141	...	...	0.0161	0.000 <b>29</b>
60	0.0129	...	...	0.0160	0.000 <b>19</b>
80	0.0085	...	...	0.0160	0.000 <b>79</b>
100	0.0000	...	...	0.0160	0.000 <b>00</b>

$l$  = Ostwald Solubility Expression, see p. 227. For  $\beta'$ ,  $\beta$ , and  $g$ , see Eth.

Data for the solubility of hydrogen in water at pressures up to 10 at are given by Cassuto, 1913.

### SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF ACIDS AND BASES AT 25°.

(Geffcken — Z. physik. Chem. 49, 268, '04.)

Gram Equiv. Acids and Bases per Liter.	Solubility of H ( $l_{25}$ = Ostwald Expression) in Solutions of:						
	HCl.	HNO <sub>3</sub> .	$\frac{1}{2}$ H <sub>2</sub> SO <sub>4</sub> .	CH <sub>3</sub> COOH.	CH <sub>3</sub> CICOOH.	KOH.	NaOH.
0.0	0.0193	0.0193	0.0193	0.0193	0.0193	0.0193	0.0193 <b>193</b>
0.5	0.0186	0.0188	0.0185	0.0192	0.0189	0.0167	0.0165 <b>165</b>
1.0	0.0179	0.0183	0.0177	0.0191	0.0186	0.0142	0.0139 <b>139</b>
2.0	0.0168	0.0174	0.0163	0.0188	0.0180	...	0.0097 <b>97</b>
3.0	0.0159	0.0167	0.0150	0.0186	...	...	0.0072 <b>72</b>
4.0	...	0.0160	0.0141	0.0186	...	...	0.0055 <b>55</b>

The above figures for the concentrations of acids and bases were calculated to grams per liter, and these values with the corresponding  $l_{25}$  values for the solubility of hydrogen, plotted on cross-section paper. From the resulting curves, the following table was read:

Grams Acids and Bases per Liter.	Solubility of H ( $l_{25}$ = Ostwald Expression) in Solutions of:						
	HCl.	HNO <sub>3</sub> .	$\frac{1}{2}$ H <sub>2</sub> SO <sub>4</sub> .	CH <sub>3</sub> COOH.	CH <sub>3</sub> CICOOH.	KOH.	NaOH.
0	0.0193	0.0193	0.0193	0.0193	0.0193	0.0193	0.0193
20	0.0185	0.0189	0.0186	0.0192	0.0191	0.0172	0.0165
40	0.0179	0.0186	0.0180	0.0191	0.0190	0.0153	0.0140
60	0.0173	0.0183	0.0174	0.0190	0.0188	0.0135	0.0117
80	0.0167	0.0180	0.0168	0.0189	0.0187	...	0.0097
100	0.0160	0.0179	0.0162	0.0189	0.0185	...	0.0082
150	...	0.0171	0.0148	0.0188	0.0182	...	0.0058
200	...	0.0165	0.0140	0.0186	0.0179	...	...
250	...	0.0160	...	0.0184	...	...	...

For Ostwald Solubility Expression  $l$ , see p. 227.

### THE SOLUBILITY OF HYDROGEN IN CONC. H<sub>2</sub>SO<sub>4</sub> AT 20°.

(Christoff, 1906.)

% H <sub>2</sub> SO <sub>4</sub>	0	35.82	61.62	95.6
$l_{20}$	0.0208	0.00954	0.00708	0.01097



# ABILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF AMMONIUM NITRATE AT 20°.

(Knopp — Z. physik. Chem. 48, 103, '04.)

	Normality (per 1000 Gms. H <sub>2</sub> O.)	Molecular Concentra- tion.	Absorption Coefficient of Hydrogen.	Density of Solutions.
0 - 00	0.00	0.00	0.0188	...
0 - 37	0.1308	0.002352	0.01872	1.0027
0 - 67	0.2765	0.004956	0.01845	1.0072
0 - 378	0.4363	0.007799	0.01823	1.0122
0 - 823	0.6333	0.011280	0.01773	1.0182
0 - 773	0.9009	0.016447	0.01744	1.0262
0 - 550	1.6308	0.028525	0.01647	1.04652

# ABILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF BARIUM CHLORIDE.

(Braun — Z. physik. Chem. 33, 735, '00.)

	Coefficient of Absorption of Hydrogen at:				
	5°.	10°.	15°.	20°.	25°.
0 - 00	0.0237	0.0221	0.0206	0.0191	0.0175
3 - 29	0.0211	0.0198	0.0185	0.0172	0.0157
3 - 6	0.0209	0.0197	0.0184	0.0170	0.0156
6 - 45	0.0196	0.0186	0.0173	0.0161	0.0147
7 - 00	0.0194	0.0183	0.0172	0.0159	0.0146

# ABILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF CALCIUM CHLORIDE, MAGNESIUM SULPHATE, AND LITHIUM CHLORIDE AT 15°.

(Gordon — Z. physik. Chem. 18, 14, '95.)

Coefficient of Absorption of hydrogen in water at 15° = 0.01883.

In Calcium Chloride.			In Magnesium Sulphate.			In Lithium Chloride.		
G. M. CaCl <sub>2</sub> per Liter.	Absorption Coefficient of H.		Gms. MgSO <sub>4</sub> per 100 g. Sol.	G. M. MgSO <sub>4</sub> per Liter.	Absorption Coefficient of H.	Gms. LiCl per 100 g. Sol.	G. M. LiCl per Liter.	Absorption Coefficient of H.
0.321	0.01619		4.97	0.433	0.01501	3.48	0.835	0.01619
0.578	0.01450		10.19	0.936	0.01159	7.34	1.800	0.01370
1.122	0.01138		23.76	2.501	0.00499	14.63	3.734	0.0099
1.1827	0.00839							
2.062	0.00519							

For definition of Coefficient of Absorption, see page 227.

# ABILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF POTASSIUM CARBONATE, CHLORIDE, AND NITRATE AT 15°.

(Gordon.)

In Potassium Carbonate.			In Potassium Chloride.			In Potassium Nitrate.		
G. M. K <sub>2</sub> CO <sub>3</sub> per Liter.	Absorption Coefficient of H.		Gms. KCl per 100 g. Sol.	G. M. KCl per Liter.	Absorption Coefficient of H.	Gms. KNO <sub>3</sub> per 100 g. Sol.	G. M. KNO <sub>3</sub> per Liter.	Absorption Coefficient of H.
0.209	0.01628		3.83	0.526	0.01667	4.73	0.482	0.01683
0.690	0.01183		7.48	1.051	0.01489	8.44	0.879	0.01559
1.376	0.00761		12.13	1.755	0.01279	16.59	1.820	0.01311
2.156	0.00462		19.21	2.909	0.01012	21.46	2.430	0.01180
4.352	0.00160		22.92	3.554	0.00892			



**SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF POTASSIUM  
CHLORIDE AND NITRATE AT 20°.**

(Knopp—Z. physik. Chem. 48, 103, '04.)

In Potassium Chloride.				In Potassium Nitrate.			
<i>p.</i>	Normality (per 1000 g. H <sub>2</sub> O).	Absorption Coefficient.	Density of Solutions.	<i>p.</i>	Normality (per 1000 g. H <sub>2</sub> O).	Absorption Coefficient.	Density of Solutions.
1.089	0.1475	0.01823	1.0052	1.224	0.1245	0.01835	1.009
2.123	0.2907	0.01757	1.0118	2.094	0.2114	0.01818	1.011
4.070	0.5687	0.01661	1.0243	4.010	0.4127	0.01785	1.023
6.375	0.9127	0.01531	1.0394	5.925	0.6225	0.01743	1.039
7.380	1.0682	0.01472	1.0460	7.742	0.8293	0.01667	1.047
13.612	2.1222	0.01255	1.0875	13.510	1.5436	0.01436	1.086

**SOLUBILITY OF HYDROGEN IN AQUEOUS SODIUM CARBONATE AND  
SULPHATE SOLUTIONS AT 15°.**

(Gordon.)

In Sodium Carbonate.			In Sodium Sulphate.		
Gms. Na <sub>2</sub> CO <sub>3</sub> per 100 Gms. Solution.	G. M. Na <sub>2</sub> CO <sub>3</sub> per Liter.	Absorption Coefficient of H.	Gms. Na <sub>2</sub> SO <sub>4</sub> per 100 Gms. Solution.	G. M. Na <sub>2</sub> SO <sub>4</sub> per Liter.	Absorption Coefficient of H.
2.15	0.207	0.01639	4.58	0.335	0.01519
8.64	0.438	0.01385	8.42	0.638	0.0154
11.53	1.218	0.00839	16.69	1.364	0.00775

**SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF SODIUM**

**CHLORIDE.**  
(Braun; Gordon.)

Gms. NaCl per 100 Gms. Solution.	Coefficient of Absorption of Hydrogen at:				
	5°.	10°.	15°.	20°.	25°.
1.25	0.0218	0.0205	0.0191	0.0177	0.0162
3.80	0.0198	0.0188	0.0176	0.0162	0.0148
4.48	0.0192	0.0182	0.0171	0.0159	0.0143
6.00	0.0184	0.0175	0.0164	0.0153	0.0138
14.78	...	...	0.0093	...	...
23.84	...	...	0.00595	...	...

**SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF SODIUM  
NITRATE.**

In Sodium Nitrate at 20°.  
(Knopp.)

In Sodium Nitrate at 20°.  
(Gordon.)

<i>p.</i>	Normality (per 1000 Gms. H <sub>2</sub> O).	Absorption Coefficient of H.	Density of Solutions.	Gms. NaNO <sub>3</sub> per 100 Gms. Solution.	G. M. NaNO <sub>3</sub> per Liter.	Absorption Coefficient of H.
1.041	0.1236	0.01839	1.0052	5.57	0.679	0.0151
2.192	0.2634	0.01774	1.0130	11.16	1.413	0.0148
4.405	0.5416	0.01694	1.0282	19.77	2.656	0.0143
6.702	0.8442	0.01518	1.04411	37.43	5.711	0.0138
12.637	1.7354	0.0130	1.08667			



## SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF VARIOUS SALTS AT 15°.

(Steiner, 1894.)

Aq. sol.	Bunsen Absorption Coefficient $\beta$ ( $\times 10^3$ ) in Aq. Solution of Normality.								
	0.	1.	2.	3.	4.	5.	6.	7.	9.
	1883	1574	1325	1121	949	...	...	...	...
	1883	1524	1276	1076	...	...	...	...	...
	1883	1511	1221	993	810	667	550	...	...
	1883	1502	1217	996	820	...	...	...	...
$\text{Na}_2\text{S}$	1883	1496	1201	984	808	667	542	...	...
$\text{Na}_2\text{SO}_4$	1883	1493	1195	958	780	635	510	...	...
	1883	1478	1144	880	699	573	...	...	...
$\text{O}_4$	1883	1451	1120	856	659	499	...	...	...
$\text{O}_4$	1883	1446	1113	852	667	510	...	...	...
$\text{IO}_4$	1883	1370	991	710	...	...	...	...	...
$\text{O}_2$	1883	1338	967	700	508	372	273	206	158
$\text{CO}_2$	1883	1340	699	...	...	...	...	...	...
Sugar	1883	1280	731	...	...	...	...	...	...

## SOLUBILITY OF HYDROGEN IN ALCOHOL. (Timofeiew, 1890; Bunsen-Heurich, 1892.)

Coef. of Absorption in 98.8% Alcohol.	t°.	Coef. of Absorption in 7% Alcohol.	t°.	Coef. of Absorption in Pure Alcohol (Bunsen).
0.0676	4	0.0749	1	0.06916
0.0693	18.8	0.0740	5	0.06847
0.0705			11.4	0.06765
			23.7	0.06633

## SOLUBILITY IN AQUEOUS ALCOHOL SOLUTIONS AT 20° AND 760 MM. PRESSURE.

(Lubarsch, 1889.)

Wt. % Alcohol.	Vol. % Absorbed H.	Wt. % Alcohol.	Vol. % Absorbed H.
0	1.93	28.57	1.04
9.09	1.43	33.33	1.17
16.67	1.29	50	2.02
23.08	1.17	66.67	2.55

## SOLUBILITY OF HYDROGEN IN AQ. SOLUTIONS OF CHLORAL HYDRATE.

(Müller, C. 1912-13.)

t°.	Gms. Chloral Hydrate per 100 Gms. Aq. Sol.	$d_m$ of Aq. Solution.	Absorption Coefficient.	
			$\beta_t$ .	$\beta_m$ .
3.4	15.5	1.0722	0.01732	0.01724
7.4	28.3	1.143	0.01569	0.01540
13.7	46.56	1.2505	0.01388	0.01375
15.5	52	1.2870	0.01314	0.01280
17	63	1.371	0.01270	0.01243
17.9	68	1.4097	0.01286	0.01270
18.3	78.4	1.4993	0.01398	0.01380

## SOLUBILITY OF HYDROGEN IN CHLORAL HYDRATE SOLUTIONS AT 20°. (Knopp, 1904.)

t°.	Normality (per 1000 Gms. $\text{H}_2\text{O}$ ).	Molecular Concentration.	Absorption Coefficient of H.	Density of Solutions.
4.91	0.310	0.005594	0.01839	1.0202
7.69	0.504	0.008992	0.01802	1.0320
4.56	1.030	0.018223	0.01712	1.0669
9.50	2.530	0.043601	0.01542	1.1466
13.42	3.770	0.063647	0.01440	1.1982
17.79	6	0.097493	0.01353	1.2724
19.90	10.700	0.161660	0.01307	1.3743

Definition of Bunsen Absorption Coef., see p. 227.



## SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF GLYCEROL.

Results at 14° and 21°. (Henkel, 1905, 1912.)

Results at 25°. (Drucker and Miles, 1920.)

t°.	Wt. % Glycerol.	Absorp. Coef. $\beta$ (See p. 227.)	Wt. % Glycerol.	$d_{25}^{20}$ Sat. Sol.	$l_{\beta}$ (Detachable Experiments)
14	0	0.0193	0	I	0.0196
"	2.29	0.0189	4	I.0101	0.0186
"	5.32	0.0186	10.5	I.0260	0.0178
"	8.57	0.0182	22	I.0542	0.0154
"	10.83	0.01815	49.8	I.1290	0.0099
"	15.31	0.01765	50.5	I.1300	0.0097
21	0	0.0184	52.6	I.1365	0.0090
"	2.29	0.0181	67	I.1752	0.0067
"	5.68	0.0177	80	I.2113	0.0051
"	6.46	0.0176	82	I.2159	0.0051
"	10.40	0.0171	88	I.2307	0.0044
"	18.20	0.0160	95	I.2502	0.0034

Additional data for this system are given by Müller, C. 1912-13.

SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF SEVERAL COMPOUNDS.  
(Hüfner, 1906-07.)

Aqueous Solution of:	Conc. of Solvent Gms. per Liter.	t.	Absorption Coef. $\beta$
Water alone	0	20.11	0.0181
Dextrose (Grape Sugar)	41.45	20	0.0176
"	87.3	20.25	0.0166
"	174	20.28	0.0152
Urea	60	20.17	0.0170
Acetamide	59	20.11	0.0180
Alanine	89	20.08	0.0156
Glycocol	75	20.16	0.0158

SOLUBILITY OF HYDROGEN IN AQUEOUS SOLUTIONS OF CANE SUGAR AND  
OF GRAPE SUGAR. (Müller, C. 1912-13.)

t°.	Wt. % Cane Sugar.	Sp. Gr. Sat. Sol.	Abs. Coef. $\beta_{15}$ .	t°.	Wt. % Grape Sugar.	Sp. Gr. Sat. Sol.	Abs. Coef. $\beta_{20}$ .
15.2	5.04	$d_{15} = 1.019$	0.0173	19.3	0	...	0.0184
11.6	14.7	$d_{11} = 1.060$	0.0151	20.5	12.2	$d_{20} = 1.048$	0.0160
12	20.26	$d_{11} = 1.084$	0.0146	20.5	20.7	$d_{20} = 1.084$	0.0145
12.7	29.86	$d_{13} = 1.128$	0.0126	21.1	32.56	$d_{20} = 1.130$	0.0125
11.8	31.74	$d_{12} = 1.138$	0.0119	21.8	45.8	$d_{20} = 1.199$	0.0102
13.3	39.65	$d_{13.5} = 1.175$	0.0103	21.2	59	$d_{20} = 1.266$	0.0078
12.6	42.94	$d_{12.5} = 1.195$	0.0094				

## SOLUBILITY OF HYDROGEN IN AQUEOUS SUGAR SOLUTIONS AT 15°. (Gordon, 1895.)

Gms. Sugar per 100 Gms. Solution.	Gm. Mols. Sugar per Liter.	Absorption Coefficient of H.
16.67	0.520	0.01561
30.08	0.993	0.01284
47.65	1.699	0.00892

## SOLUBILITY OF HYDROGEN AT 25° (Findlay and Shen, 1912) IN AQ. SOLUTIONS OF:

Dextrin.			Starch.			Gelatin.		
Gms. Dextrin per 100 cc.	Sp. Gr.	$l_{25}$ .	Gms. Starch per 100 cc.	Sp. Gr.	$l_{25}$ .	Gms. Gelatin per 100 cc.	$l_{25}$ .	
3.08	1.012	0.0194	2.01	1.005	0.0194	1.53	0.0194	
8.58	1.019	0.0191	3.56	1.011	0.0189	2.69	0.0189	
8.12	1.028	0.0188	7.13	1.024	0.0181	4.74	0.0185	
19.20	1.066	0.0174	9.29	1.032	0.0182	5.71	0.0182	



**SOLUBILITY OF HYDROGEN IN AQUEOUS PROPIONIC ACID SOLUTIONS.**  
(Braun, 1900.)

Gms. $C_2H_5COOH$ per 100 Gms. Solution.	Coefficient of Absorption of Hydrogen at:				
	5°.	10°.	15°.	20°.	25°.
2.63	0.02245	0.0214	0.0200	0.0188	0.0172
3.37	0.0222	0.0212	0.0199	0.0187	0.0171
5.27	0.0224	0.0212	0.0198	0.0184	0.0171
6.50	0.0218	0.0209	0.0193	0.0183	0.0169
9.91	0.0213	0.0203	0.0191	0.0178	0.0160

**SOLUBILITY OF HYDROGEN IN RUSSIAN PETROLEUM.**  
(Gniewass and Walfisz, 1887.)

Coefficient of absorption (see p. 227) at 20° = 0.0582, at 10° = 0.0652.

**SOLUBILITY OF HYDROGEN IN WATER AND IN ORGANIC SOLVENTS.**

Results in terms of the Ostwald Expression, see p. 227. (Just, 1901.)

Solvent.	$l_{25}$	$l_{10}$	Solvent.	$l_{25}$	$l_{10}$
Water	0.0199	0.0200	Amyl Acetate	0.0774	0.0743
Aniline	0.0285	0.0303	Xylene	0.0819	0.0783
Amyl Alcohol	0.0301	0.0353	Ethyl Acetate	0.0852	0.0788
Nitrobenzene	0.0371	0.0353	Toluene	0.0874	0.0838
Carbon Disulfide	0.0375	0.0336	Ethyl Alcohol (98.8%)	0.0894	0.0862
Acetic Acid	0.0633	0.0617	Methyl Alcohol	0.0945	0.0902
Benzene	0.0756	0.0707	Isobutyl Alcohol	0.0976	0.0929
Acetone	0.0764	0.0703			

**SOLUBILITY OF HYDROGEN IN ETHYL ETHER.**  
(Christoff, 1912.)

Results in terms of the Ostwald Solubility Expression  $l$  (see p. 227).

$$l_0 = 0.1115, \quad l_5 = 0.1150, \quad l_{10} = 0.1195, \quad l_{15} = 0.1259.$$

Data for the solubility of hydrogen in metals are given by Sieverts and co-workers, 1909, 1910, 1912.

**HYDROGEN PEROXIDE  $H_2O_2$ .**

**DISTRIBUTION OF HYDROGEN PEROXIDE BETWEEN WATER AND AMYL ALCOHOL  
AT 0° AND AT 25°.**  
(Calvert, 1901; Joyner, 1912.)

Results at 0°. (Calvert, Joyner.)			Results at 25°. (Calvert.)		
Mols. $H_2O_2$ per Liter.		$\frac{W}{A}$	Mols. $H_2O_2$ per Liter.		$\frac{W}{A}$
Water Layer (W).	Alcohol Layer (A).		$H_2O$ Layer (W).	Alcohol Layer (A).	
0.146	0.0216	6.76	0.094	0.013	7.01
0.200	0.030	6.66	0.194	0.028	6.91
0.407	0.061	6.63	0.297	0.042	7.08
0.749	0.113	6.66	0.670	0.095	7.09
1.970	0.293	6.71	0.913	0.130	7.01

Data are also given for the distribution of hydrogen peroxide between aqueous sodium hydroxide solutions and amyl alcohol at 0° and at 25°.



## HYDROGEN PEROXIDE

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### DISTRIBUTION OF HYDROGEN PEROXIDE BETWEEN WATER AND ORGANIC SOLVENTS (Walton and Lewis, 1916.)

Different amounts of perhydrol (30%  $H_2O_2$  solution) were added to various mixtures of water and organic solvents and, after constant agitation for about 1 hour, the  $H_2O_2$  in each layer was determined.

Solvent	t°.	Ratio, Conc. aq. Conc. org. solvent	Solvent.	t°.	Ratio, Conc. aq. Conc. org. solvent
Ethyl Acetate	25	3.92-4.11	Methyl Iodide	25	Approx. 200
Isobutyl Alcohol	25	2.58-2.63	m Toluidine	25	Approx. 5
Amyl Acetate	25	13-13.2	Phenol	25	4.35-5-55
Acetophenone	25	5.82-6.06	Quinoline	0	0.276-0-391
Ether	25	8.28-9.11	"	25	0.365-0-642
Ether	0	5.72-5.85	"	40	0.516-0-602
Aniline	25	4.08-4.10			

The following approximate values, determined at room temp., are quoted from the dissertation of A. Braun, Univ., Wisconsin, 1914.

Solvent.	Ratio, Conc. aq. Conc. org. solvent	Solvent.	Ratio, Conc. aq. Conc. org. solvent	Solvent.	Ratio, Conc. aq. Conc. org. solvent
Ethyl Acetate	$\frac{1}{100}$	Ethylisovalerianate	$\frac{1}{100}$	Isobutyl Alcohol	$\frac{1}{100}$
Nitrobenzene	$\frac{1}{100}$	Isoamyl Propionate	$\frac{1}{100}$	Propyl Formate	$\frac{1}{100}$
Acetophenone	$\frac{1}{100}$	Chloroform	$\frac{1}{100}$	Isobutyl Butyrate	$\frac{1}{100}$
Amyl Acetate	$\frac{1}{100}$	Benzene	$\frac{1}{100}$	Propyl Butyrate	$\frac{1}{100}$

The distribution ratio of hydrogen peroxide between water and ether at varies with concentration from 13.9 to 17.4. (Osipoff and Popoff, 1911.)

## HYDROGEN SELENIDE $H_2Se$

### SOLUBILITY IN WATER. (de Forcrand and Fonzes-Diacon, 1902.)

t°.	Vol. $H_2Se$ (at 0° and 760 mm.) dissolved per 1 vol. $H_2O$	4°	9.65	13.2	22.——5
		3.77	3.45	3.31	2. 70

## HYDROGEN SULFIDE $H_2S$

### SOLUBILITY IN WATER. (Winkler, 1906, 1912.)

t°.	Abs. Coef. $\beta$ .	g.	t°.	Abs. Coef. $\beta$ .	g.	t°.	Abs. Coef. $\beta$ .	g.
0	4.621	0.699	25	2.257	0.334	60	1.176	0.146
5	3.935	0.593	30	2.014	0.295	70	1.010	0.109
10	3.362	0.505	35	1.811	0.262	80	0.906	0.076
15	2.913	0.436	40	1.642	0.233	90	0.835	0.041
20	2.554	0.380	50	1.376	0.186	100	0.800	0

### SOLUBILITY IN WATER AND IN ALCOHOL AT t° AND 760 MM. PRESSURE. (Bunsen and Carius; Fauser, 1888.)

In Water.			In Alcohol.		
t°.	1 Vol. $H_2O$ Absorbs.	$\beta$ .	t°.	1 Vol. Alcohol Absorbs.	$\beta$ .
0	4.37 Vols. $H_2S$ (at 0° and 760 mm.)	4.686	0.710	17.89 Vols. $H_2S$ (at 0° and 760 mm.)	17.89
5	3.97	4.063	0.615	14.78	"
10	3.59	3.520	0.530	11.99	"
15	3.23	3.056	0.458	9.54	"
20	2.91	2.672	0.398	7.42	"
25	2.61	...	...	5.96 (24°)	"
30	2.33	...	...	...	...
35	2.08	...	...	...	...
40	1.86	...	...	...	...

For  $\beta$  and  $g$  see Ethane, page 285.

The  $PT$  and the  $Px$  curves for the system  $H_2S + H_2O$  are given by Scheffer, 1911.



**F HYDROGEN SULFIDE IN AQUEOUS SOLUTIONS OF HYDRIODIC ACID AT 25° AND 760 MM. TOTAL PRESSURE.**

(Pollitzer, 1909.)

ter. [H <sub>2</sub> S].	Gms. per Liter.		Mols. per Liter.			Gms. per Liter.	
	HI.	H <sub>2</sub> S.	[H <sup>+</sup> ].	[HI].	[H <sub>2</sub> S].	HI.	H <sub>2</sub> S.
0.1040	0	3.54	4.71	4.38	0.163	560.4	5.55
0.111	129.2	3.78	5.33	5.005	0.165	640.3	5.62
0.113	193.2	3.85	6.06	5.695	0.181	728.6	6.17
0.125	246.9	4.26	7.33	6.935	0.197	887.2	6.71
0.138	337.8	4.70	9.75	9.21	0.267	1179	9.10
0.142	437.5	4.84					

solubility of hydrogen sulfide in liquid sulfur are given by Pelant lowering data for mixtures of H<sub>2</sub>S and CH<sub>3</sub>OH and H<sub>2</sub>S and ven by Baume and Perrot, 1911, 1914.

**OF HYDROGEN SULFIDE IN AQUEOUS SALT SOLUTIONS AT 25°.**

(McLauchlan, 1903.)

original results are given in terms of  $\frac{l}{l_0}$  which is the iodine titer ( $l$ ) solved in the salt solution, divided by the titer ( $l_0$ ), of the H<sub>2</sub>S dissolved in water. These figures were multiplied by 2.61 (see 25° result in page 322) and the products recorded in the following table as absorbed by 1 vol. of aqueous solution.

	Grams Salt per Liter.	$\frac{l}{l_0}$	Vols. H <sub>2</sub> S per 1 Vol. Sol.	Solution.	Grams Salt per Liter.	$\frac{l}{l_0}$	Vols. H <sub>2</sub> S per 1 Vol. Sol.
	98	1	2.61	n KBr	119	0.945	2.47
	53.4	0.96	2.40	n KCl	74.5	0.853	2.22
	80	0.99	2.58	n KNO <sub>3</sub>	101	0.913	2.38
	33	0.82	2.14	$\frac{1}{2}$ n K <sub>2</sub> SO <sub>4</sub>	43.5	0.78	2.04
	16.5	0.91	2.37	$\frac{1}{2}$ n K <sub>2</sub> SO <sub>4</sub>	21.7	0.89	2.32
$h_2$	77.1	1.09	2.84	n KI	166	0.98	2.56
	60.1	1.02	2.66	n NaBr	103	0.935	2.44
	18.22	0.975	2.54	n NaCl	58.5	0.847	2.21
	24.52	0.905	2.36	$\frac{1}{2}$ n NaCl	29.2	0.93	2.42
	150	0.944	2.46	n NaNO <sub>3</sub>	85	0.893	2.32
	450	0.858	2.24	$\frac{1}{2}$ n Na <sub>2</sub> SO <sub>4</sub>	35.5	0.73	1.90
$D_2$	1000	0.863	2.26	$\frac{1}{2}$ n Na <sub>2</sub> SO <sub>4</sub>	17.8	0.855	2.23

are also given for the solubility of H<sub>2</sub>S in aq. C<sub>2</sub>H<sub>5</sub>OH solutions, COOH solutions at 25°.

**SOL** (Hydroquinone) C<sub>6</sub>H<sub>4</sub>(OH)<sub>2</sub>  $p$ .

1. solution in water contain 6.7 gms. hydroquinol at 20°, Sp. Gr. of (Vaubel, 1899.)

% formic acid dissolve 6.07 gms. hydroquinol at 20.2°. (Aschan, 1913.)



## HYDROQUINOL

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SOLUBILITY OF HYDROQUINOL IN SULFUR DIOXIDE IN THE CRITICAL VICINITY  
(Centnerswer and Teletow, 1903.)

Determinations made by the Synthetic Method, for which see Note <sup>1</sup>, p. 16.

t°.	Gms. Hydroquinol per 100 Gms. SO <sub>2</sub>	t°.	Gms. Hydroquinol per 100 Gms. SO <sub>2</sub>	t°.	Gms. Hydroquinol per 100 Gms. SO <sub>2</sub>
63	0.89	117.6	4.46	136.7	10.31
73.5	1.22	123.3	5.66	141.4	13.3
89.2	2.18	134.2	8.31	145	14.9

DISTRIBUTION OF HYDROQUINOL BETWEEN WATER AND ETHER AT 15°  
(Pinnow, 1911.)

Conc.* Hydroquinol in:		Conc. Hydroquinol in:	
H <sub>2</sub> O Layer.	Ether Layer.	H <sub>2</sub> O Layer.	Ether Layer.
0.00502	0.0111	0.0502	0.1275
0.01196	0.0249	0.0818	0.2343
0.0128	0.0274	0.1105	0.3543
0.0236	0.0552	0.1411	0.5300
0.0455	0.1148	0.1502	0.5604

\* The terms in which the conc. is expressed are not stated.

FREEZING-POINT DATA (Solubility, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES:

Hydroquinol and Naphthalene.	(Kremann and Janetaky, 1912.)
" " Pyrocatechol.	(Jaeger, 1907.)
" " Resorcinol.	" "
" " p Toluidine.	(Philip and Smith, 1905.)

Monochlorohydroquinol and Monobromohydroquinol. (Küster, 1891.)

Diacetylmonochlorohydroquinol and Diacetylmonobromohydroquinol.

(Küster, 19

## HYDROXYLAMINE NH<sub>2</sub>(OH).

## HYDROXYLAMINE HYDROCHLORIDE NH<sub>2</sub>(OH).HCl.

SOLUBILITY OF EACH IN SEVERAL SOLVENTS.  
(de Bruyn, 1892.)

Solvent.	t°.	Gms. NH <sub>2</sub> OH per 100 Gms. Solution.	t°.	Gms. NH <sub>2</sub> (OH).H per 100 Gms. Solvent.
Methyl Alcohol (abs.)	5	35	19.75	16.4
Ethyl Alcohol (abs.)	15	15	19.75	4.43
Ether (dry)	(b. pt.)	1.2	...	...
Ethyl Acetate	(b. pt.)	1.6	...	...

For densities of NH<sub>2</sub>(OH).HCl solutions, see Schiff and Monsacchi, 1896.

PhthalylHYDROXYLAMINE  $C_6H_4 \begin{matrix} \text{CO} \\ \text{C:NOH} \end{matrix} > O$ .

One liter benzene dissolves 0.33 gm. of the A form of melting point 220°-22  
(Sidgwick, 19

## HYOSCYAMINE C<sub>17</sub>H<sub>23</sub>NO<sub>3</sub>.

SOLUBILITY IN SEVERAL SOLVENTS AT 18°-22°.  
(Müller, 1903.)

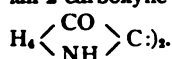
Solvent.	Gms. C <sub>17</sub> H <sub>23</sub> NO <sub>3</sub> per 100 Gms. Solution.	Solvent.	Gms. C <sub>17</sub> H <sub>23</sub> per 100 Gm Solution.
Water	0.355	Chloroform	100+
Ether	2.02	Acetic Ether	4.903
Ether sat. with H <sub>2</sub> O	3.913	Petroleum Ether	0.008
Water sat. with Ether	3.125	Carbon Tetrachloride	0.059
Benzene	0.769		



(Scopolamine) **HYDROBROMIDE**, etc.

SOLUBILITY IN SEVERAL SOLVENTS AT 25°. (U. S. P. VIII.)

Grams per 100 Grams Solvent.		
Hyosine Hydrobromide $C_{17}H_{21}NO_4 \cdot HBr \cdot 3H_2O$	Hyoscyamine Hydrobromide $C_{17}H_{21}NO_4 \cdot HBr$	Hyoscyamine Sulfate $(C_{17}H_{21}NO_4)_2 \cdot H_2SO_4$
66.6	very soluble	very soluble
6.2	50	15.6
...	0.062	0.04
0.133	40	0.043

**I** Carboxylic Acids.Ant lowering data for mixtures of *l* nitroindan-2-carboxylic acid and indan-2-carboxylic acid are given by Mills, Parker and Prowse, 1914.

; % formic acid dissolve 0.14 gm. indigo at 19.8°. (Aschan, 1913.)

**DATE**  $In(IO_3)_3$ .O dissolve 0.067 gm.  $In(IO_3)_3$  at 20°. (Mathers and Schluederberg, 1908.)**L**  $C_8H_{12}O_4$ .O dissolve 25.12 gms.  $C_8H_{12}O_4$  at 18° and 43.22 gms. at 100°. (Müller, 1912.)**D**  $HIO_3$ .

SOLUBILITY OF IODIC ACID IN WATER. (Groschuff, 1906.)

Gms. $I_2O_5$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $I_2O_5$ per 100 Gms. Sat. Sol.	Solid Phase.
1.69	Ice	16	71.7	$HIO_3$
6.81	"	40	73.7	"
26.22	"	60	75.9	"
51.42	"	80	78.3	"
57.61	"	85	78.7	"
67.40	"	101	80.8	"
69.10	" + $HIO_3$	110	82.1	$HIO_3 + HI_2O_3$
70	(unstable) Ice	125	82.7	$HI_2O_3$
72	" "	140	83.8	"
70.3	$HIO_3$	160	85.9	"

SOLUBILITY OF IODIC ACID IN NITRIC ACID. (Groschuff.)

Gms. $HIO_3$ per 100 Gms.			
t°.	Aq. Solution.	27.73% $HNO_3$ Solution.	40.88% $HNO_3$ Solution.
0	74.1	18	9
20	75.8	21	10
40	77.7	27	14
60	80	38	18

SOLUBILITY OF IODINE IN WATER. (Hartley, 1908.)

t°.	Gms. I per 1000 Gms. $H_2O$ .
18	0.2765
25	0.3395
35	0.4661
45	0.6474
55	0.9222

determinations were made with great care. Results for single in good agreement with the above are given by Dietz, 1898; 95; Noyes and Seidensticker, 1898; Sammet, 1905; Bray and 0, 1911; Herz and Paul, 1914 and Fedotieff, 1911-12.



SOLUBILITY OF IODINE IN AQUEOUS MERCURIC CHLORIDE AND IN CADMIUM IODIDE SOLUTIONS AT 25°.

In Aq. HgCl <sub>2</sub> . (Herr and Paul, 1914.)				In Aq. Cd (Van Name and Brewster, 1914.)	
Millimols per Liter.		Gms. per Liter.		Gms. per Liter.	
Hg.	I <sub>2</sub> .	HgCl <sub>2</sub> .	I.	CdI <sub>2</sub> .	
0	1.34	0	0.340	3.66	
94.44	12.94	25.64	3.285	45.78	
124.42	14.60	33.78	3.706	91.56	
195.42	18.06	54.29	4.583	183.12	
334.60	25.43	90.84	6.454		

SOLUBILITY OF IODINE IN VERY DILUTE AQUEOUS SOLUTIONS OF POTASSIUM IODIDE.

(Determinations made with very great care.)

Results at 0°. (Jones and Hartman, 1915.)			Results at 25°. (Bray and MacKay, 1910.)		Results at 25°. (Noyes and Seidenstrick, 1910.)	
Normality of Aq. KI Sol.	d of Sat. Sol.	Gms. I per 100 Gms. Sat. Sol.	Normality of Aq. KI Sol.	Millimols I <sub>2</sub> per Liter Sat. Sol.	Normality of Aq. KI Sol.	Millimols I <sub>2</sub> per Liter Sat. Sol.
0.000992	1.0002	0.0282	0	1.333	0	1
0.00200	1.0004	0.0409	0.001	1.788	0.00083	1
0.00500	1.0010	0.0760	0.002	2.266	0.00166	2
0.01000	1.0020	0.1356	0.005	3.728	0.00664	4
0.01988	1.0044	0.2533	0.010	6.185	0.01329	8
0.0500	1.0109	0.609	0.020	11.13	0.02657	4
0.09993	1.0219	1.199	0.050	25.77	0.05315	28
			0.100	51.35	0.1063	55

SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF POTASSIUM IODIDE 25° AND VICE VERSA.

(Parsons and Whittemore, 1911.)

(Time of rotation 6 mos. or longer. Duplicate determinations at different lengths of time, w

Sp. Gr. Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Sp. Gr. Sat. Sol.	Gms. per 100 Gms. Sat. Sol.	
	KI	I			KI	I
1.349	16.03	18.49	Iodine	3.246	27.92	66.45
1.516	19.70	26.16	"	3.232	29.71	62.81
1.769	22.88	36.06	"	2.665	35.80	49.61
1.910	23.55	40.52	"	2.539	38.09	44.58
2.403	24.78	53.60	"	2.216	44.82	31.01
2.904	25	63.12	"	2.066	49.04	23.08
3.082	25.18	66.04	"	1.888	54.41	11.63
3.316	26	68.09	" + KI	1.733	60.39	0

Additional data for this system are given by Bruner, 1898; Hamberge and Lami, 1908.

Data for the solubility of iodine in aq. 40% ethyl alcohol and aq. 60% alcohol solutions of potassium iodide at 25°, are given by Parsons and 1910. The solid phases were identified in each case and it was demonstrated that no polyiodides of potassium exist in the solid phase or in solution at

An extensive series of determinations of the simultaneous solubility of iodine and potassium iodide in nitrobenzene and in other organic solvents, as in mixtures of nitrobenzene and other solvents are given by Dawson and 1902, and Dawson, 1904. The determinations were made to obtain information on the formation of polyiodides in solution. The molecular ratio of I<sub>2</sub>/KI was found to be 1 or more in all cases. (See also p. 537.)

Freezing-point lowering data, determined by time-cooling curves, for iodine and potassium iodide are given by Kremann and Schoulz, 1912 for this system are also given by Olivari (1908).



**SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF POTASSIUM BROMIDE  
AND OF SODIUM BROMIDE AT 25°.**  
(Bell and Buckley, 1912.)

In Aq. KBr Solutions.		In Aq. NaBr Solutions.	
Gms. KBr per Liter.	Gm. Atoms I per Liter.	Gms. NaBr per Liter.	Gm. Atoms I per Liter.
60.6	0.0176	96.4	0.0266
106.9	0.0278	187.7	0.0425
175.9	0.0415	271.8	0.0538
229.8	0.0532	357.4	0.0598
281.9	0.0628	422.21	0.0638
330.6	0.0717	499.1	0.0648
377.1	0.0797	569.9	0.0644
411	0.0864	632	0.0622
461.7	0.0948	679.7	0.0595
509.8	0.1006	750.5	0.0551
567.9 sat.	0.1094	756.1 sat.	0.0550

**SOLUBILITY OF IODINE IN AQUEOUS SOLUTIONS OF ACIDS.**

Aqueous Acid.	Mols. I per Liter Sat. Sol.	Gms. I per Liter Sat. Sol.	Authority.
0.001 % HCl	0.001332	0.338	(Bray and MacKay, 1910.)
0.10 % HNO <sub>3</sub>	0.001340	0.340	(Sammet, 1905.)
0.10 % H <sub>2</sub> SO <sub>4</sub>	0.001342	0.341	"

**SOLUBILITY OF IODINE IN AQUEOUS SODIUM IODIDE SOLUTIONS.**

(Gill, 1913-14.)

Aqueous NaI solutions were prepared by dissolving the stated amounts of the salt in water and diluting to 100 cc. An excess of iodine was added to each of these solutions, the mixtures heated to 60° and shaken for several minutes. They were then allowed to cool in a thermostat at 25° for four hours. The dissolved iodine in weighed amounts of the saturated solutions was titrated with thiosulfate. The densities of the Aq. NaI mixtures and also of the solutions after saturation with iodine were determined.

Gms. NaI per 100 cc. Aq. Solution.	$d_{25}$ of Aq. NaI Solution.	$d_{25}$ of Aq. NaI after Saturation with I.	Gms. I Dissolved at 25° per 100 Gms. of the Sat. Sol.
5	1.0369	1.0698	4.99
10	1.0720	1.1415	9.96
15	1.1072	1.2162	14.93
20	1.1458	1.2998	20.02

Determinations at other temperatures were made in an apparatus which permitted constant stirring of the solutions at the several temperatures. Results, interpolated from the original, are as follows:

t°.	Gms. I Dissolved per 100 Gms. Sat. Solution in Aq. NaI of:		t°.	Gms. I Dissolved per 100 Gms. Sat. Solution in Aq. NaI of:	
	10 Gms. per 100 cc.	20 Gms. per 100 cc.		10 Gms. per 100 cc.	20 Gms. per 100 cc.
10	8.9	17.6	30	10.3	20.5
15	9.3	18.3	40	10.9	22
20	9.6	19	50	11.7	23.4
25	10	19.4	60	12.6	24.9



SOLUBILITY OF IODINE IN AQUEOUS SALT SOLUTIONS AT 21°  
(McLauchlan, 1903.)

Salt.	Gms. Salt per Liter.	Gms. Dissolved I per Liter.	{Salt.	Gms. Salt. per Liter.
Na <sub>2</sub> SO <sub>4</sub>	29.77	0.160	NH <sub>4</sub> Cl	53.4
K <sub>2</sub> SO <sub>4</sub>	43.5	0.238	NaBr	103
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	33	0.246	KBr	119
NaNO <sub>3</sub>	85	0.257	NH <sub>4</sub> Br	98
KNO <sub>3</sub>	101.2	0.266	NH <sub>4</sub> C <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	77.1
NH <sub>4</sub> NO <sub>3</sub>	80	0.375	(NH <sub>4</sub> ) <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	86.9
NaCl	58.5	0.575	H <sub>3</sub> BO <sub>3</sub>	55.8
KCl	73.6	0.658		

SOLUBILITY OF IODINE IN NITROBENZENE SOLUTIONS CONTAINING  
IODIDES AT ROOM TEMPERATURE. SOLUTIONS SAT. WITH I IN E  
(Dawson and Goodson, 1904.)

Iodide.	Gms. per Liter.		Iodide.	
	Iodide.	Iodine.		
Potassium Iodide	12.35	112.7	Caesium Iodide*	
" "	45.56	295.7	Caesium Iodide	
" "	115.8	698.2	Ammonium Iodide	
" "	155.2	943.6	Ammonium Iodide*	
Sodium Iodide	13.55	125	Aniline Hydriodide	
" "	57.7	393	Dimethylaniline Hydriodide	
" "	109.1	738	Tetramethylammonium Iodide	
" "	228	1251	Tetramethylammonium Iodide	
Rubidium Iodide	85.4	421	Strontium Iodide	
Rubidium Iodide	217.5	1060	Barium Iodide	
Lithium Iodide	84.1	642	Barium Iodide	

\* Solvent = o nitrotoluene instead of nitrobenzene.

Similar results are also given for solutions containing KI in add other iodide, and one series for the simultaneous solubility of KBr an benzene. It is considered that the increased solubility is most easi on the assumption that periodides are formed in solution.

SOLUBILITY OF IODINE IN AQUEOUS ETHYL AND NORMAL PROPYL  
SOLUTIONS AT 15°.

(Bruner, 1898.)

In Aq. Ethyl Alcohol.				In Aq. (n.) Propyl A			
Vol. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	Gms. I per 100 cc. Solution.	Vol. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	Gms. I per 100 cc. Solution.	Vol. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	Gms. I per 100 cc. Solution.	Vol. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	Gms. I per 100 cc. Solution.
10	0.05	60	1.14	10	0.05	60	
20	0.06	70	2.33	20	0.11	70	
30	0.10	80	4.20	30	0.40	80	
40	0.26	90	7.47	40	0.94	90	
50	0.88	100	15.67	50	1.64	100	



SOLUBILITY OF IODINE IN AQUEOUS ETHYL ALCOHOL AND IN AQUEOUS ACETIC ACID SOLUTIONS AT 25°.

(McLauchlan, 1903.)

In Aq. C <sub>2</sub> H <sub>5</sub> OH Solutions.		In Aq. CH <sub>3</sub> COOH Solutions.	
Gms. C <sub>2</sub> H <sub>5</sub> OH per 100 Gms. Solvent.	Gms. I per 100 cc. Sat. Solution.	Gms. CH <sub>3</sub> COOH per 100 Gms. Solvent.	Gms. I per 100 cc. Sat. Solution.
0	0.034	0	0.034
4.55	0.039	20	0.076
28.48	0.172	39.5	0.173
44.41	0.955	61.1	0.510
72.51	6.698	80.7	1.363
100	24.548	100	3.162

SOLUBILITY OF IODINE IN AQUEOUS GLYCEROL SOLUTIONS AT 25°.

(Hertz and Knoch, 1905.)

Density of glycerine at 25°/4° = 1.2555; impurities about 1.5%.

Wt. % Glycerine in Solvent.	Millimols I per 100 cc. Solution.	Grams I per 100 cc. Solution.	Density of Solutions at 25°/4°.
0	0.24	0.0304	0.9979
7.15	0.27	0.0342	1.0198
20.44	0.38	0.0482	1.0471
31.55	0.49	0.0621	1.0750
40.95	0.69	0.0875	1.0995
48.7	1.07	0.135	1.1207
69.2	2.20	0.278	1.1765
100.0	9.70	1.223	1.2646

100 gms. glycerol ( $d_{44} = 1.256$ ) dissolve 2 gms. iodine at 15°-16°.

(Ossendowski, 1907.)

SOLUBILITY OF IODINE IN BENZENE, CHLOROFORM, AND IN ETHER.

(Arciowski — Z. anorg. Chem. 11, 276, '95-'96.)

In Benzene.		In Chloroform.		In Ether.	
t°.	Gms. I per 100 Gms. Solution.	t°.	Gms. I per 100 Gms. Solution.	t°.	Gms. I per 100 Gms. Solution.
4.7	8.08	-49	0.188	-83	15.39
6.6	8.63	-55½	0.144	-90	14.58
10.5	9.60	-60	0.129	-108	15.09
13.7	10.44	-69½	0.089		
16.3	11.23	-73½	0.080		
		+10	1.76 per 100 gms. CHCl <sub>3</sub>		

(Duncan — Pharm. J. Trans. 22, 544, '91-'92.)

SOLUBILITY OF IODINE IN BROMOFORM, CARBON TETRACHLORIDE, AND IN CARBON DISULFIDE AT 25°.

(Jakowkin, 1895.)

liter of saturated solution in CHBr<sub>3</sub> contains 189.55 gms. I.

liter of saturated solution in CCl<sub>4</sub> contains 30.33 gms. I.

liter of saturated solution in CS<sub>2</sub> contains 230 gms. I.



SOLUBILITY OF IODINE IN CARBON DISULFIDE.  
(Arctowski, 1894.)

t°.	Gms. I per 100 Gms. Solution.	t°.	Gms. I per 100 Gms. Solution.	t°.	Gms. I per Gms. Sol.
-100	0.32	0	7.89	30	19.2
-80	0.51	10	10.51	36	22.6
-63	1.26	15	12.35	40	25.2
-20	4.14	20	14.62	42	26.7
-10	5.52	25	16.92		

SOLUBILITY OF IODINE IN SEVERAL SOLVENTS AT 25°.  
(Herz and Rathmann, 1913.)

Solvent.	Iodine per Liter of Sat. Sol.		Solvent.	Iodine per I Sat. So	
	Mols.	Gms.		Mols.	Gms.
Chloroform	0.352	44.68	Trichlorethylene	0.312	39
Carbon Tetrachloride	0.237	30.08	Tetrachlorethane	0.244	30
Tetrachlorethylene	0.241	30.59	Pentachlorethane	0.272	34

One liter sat. solution of iodine in nitrobenzene contains 50.62 gms. I at 16°.  
(Dawson and Gawler, 1911.)  
100 gms. hexane dissolve 1.32 gms. iodine at 25°. (Hildebrand, Ellefsen and Beebe, 1911.)  
100 gms. sat. solution of iodine in anhydrous lanolin (melting point 46°), contain 5.50 gms. iodine at 45°. (Klose, 1911.)

SOLUBILITY OF IODINE IN MIXTURES OF CHLOROFORM AND ETHER AT 25°  
(Marden and Dover, 1916.)

Gms. CHCl <sub>3</sub> per 100 Gms. CHCl <sub>3</sub> + (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	Gms. Iodine per 100 Gms. CHCl <sub>3</sub> + (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	Gms. CHCl <sub>3</sub> per 100 Gms. CHCl <sub>3</sub> + (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	Gms. Iodine per 100 G CHCl <sub>3</sub> + (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.
0	35.1	60	9.83
10	29.6	70	7.5
20	24.8	80	5.73
30	20.2	90	4.31
40	16.3	100	3.10
50	12.7		

100 cc. of a mixture of CHCl<sub>3</sub> + CS<sub>2</sub> (3:1) dissolve 7.39 gms. iodine (Olivari, 1911).  
The addition of S even up to the point of saturation does not affect the amount of iodine held in solution.

Diagrammatic results for mixtures of iodine and each of the following compounds are given by Olivari, 1911: CHI<sub>3</sub>, p C<sub>6</sub>H<sub>5</sub>Br<sub>2</sub>, [C<sub>6</sub>H<sub>5</sub>]<sub>3</sub>N<sub>2</sub>, p C<sub>6</sub>H<sub>5</sub>(N(C<sub>6</sub>H<sub>5</sub>CO))<sub>2</sub>O and C<sub>6</sub>H<sub>5</sub>COOH.

SOLUBILITY OF IODINE IN MIXED SOLVENTS AT 16.6°.  
(Strömholm, 1903.)

Solvent.	Gms. I per Liter Sat. Sol.	Solvent.	Gms. I per Liter Sat. Sol.
Ether	206.3	Ether + 20.96 gms. CS <sub>2</sub> per liter	
Carbon Disulfide	178.5	Ether + 41.9 " CS <sub>2</sub> "	
Ether + 3.96 gms. H <sub>2</sub> O per liter	221	CS <sub>2</sub> + 22.5 " ether "	
" + 7.91 gms. H <sub>2</sub> O "	235.7	CS <sub>2</sub> + 45.1 " ether "	
" + excess H <sub>2</sub> O "	251.4	Ether + 47.63 " CHCl <sub>3</sub> "	
" + 9.79 gms. C <sub>2</sub> H <sub>5</sub> OH "	219.1	CS <sub>2</sub> + 50.06 " CHCl <sub>3</sub> "	
" + 19.6 " " "	231.5	Ether + 80.3 " C <sub>6</sub> H <sub>6</sub> "	
" + 29.4 " " "	243.9	Ether + 77.85 " CH <sub>3</sub> I "	
" + 39.2 " " "	254.4	CS <sub>2</sub> + 62.2 " S "	

One liter sat. solution in ether contains 167.3 gms. I at 0°. (Strömholm, 1903.)



OF IODINE IN MIXTURES OF CHLOROFORM AND ETHYL ALCOHOL,  
 IN AND NORMAL PROPYL ALCOHOL, CHLOROFORM AND BENZENE,  
 CHLOROFORM AND CARBON DISULFIDE AT 15°.

(Bruner, 1898.)

Gms. I Dissolved per 100 cc. of Mixtures of:			
$\text{CHCl}_3 + \text{C}_2\text{H}_5\text{OH.}$	$\text{CHCl}_3 + \text{C}_3\text{H}_7\text{OH.}$	$\text{CHCl}_3 + \text{C}_6\text{H}_6.$	$\text{CHCl}_3 + \text{CS}_2.$
15.67	14.93	10.40	17.63
9.43	13.16	9.84	15.93
8.69	11.20	8.78	14.20
7.80	8.98	7.74	12.16
7.09	8.09	6.96	10.20
6.62	7.82	6.20	9.08
6.24	7.09	5.34	7.72
5.77	6.42	4.89	6.42
5.06	5.54	4.53	5.27
4.34	4.52	4.07	4.32
3.62	3.62	3.62	3.62

OF IODINE IN MIXTURES OF CARBON TETRACHLORIDE AND BEN-  
 ZENE, IN MIXTURES OF CARBON TETRACHLORIDE AND CARBON DISUL-  
 FIDE AT 15°.

(Bruner, 1898.)

Gms. I per 100 cc. of Mixture of:		Vol. % $\text{CCl}_4$ in Solvent.	Gms. I per 100 cc. of Mixture of:	
$\text{CCl}_4 + \text{C}_6\text{H}_6.$	$\text{CCl}_4 + \text{CS}_2.$		$\text{CCl}_4 + \text{C}_6\text{H}_6.$	$\text{CCl}_4 + \text{CS}_2.$
10.40	17.6	60	4.90	5.55
9.44	14.44	70	4.09	4.50
8.53	12.33	80	3.41	3.37
7.77	10.34	90	2.74	2.60
6.63	8.60	100	2.06	2.06
5.70	6.83			

of the above determinations the volume change occurring on mixing  
 was neglected. The temperature was not accurately regulated and  
 not shaken during the saturation. The curves plotted from the  
 data are smooth.

OF IODINE BETWEEN WATER AND BROMOFORM, WATER AND CAR-  
 BON DISULFIDE, AND WATER AND CARBON TETRACHLORIDE AT 25°.

(Jakowkin, 1895.)

Results were plotted on cross-section paper and the following table made from the curves.  
 Note that the results of Berthelot and Jungfleisch, 1872, are incorrect on account of the

Gms. I per Liter of $\text{H}_2\text{O}$ Layer in Each Case.	Gms. I per Liter of:		
	$\text{CHBr}_3$ Layer.	$\text{CS}_2$ Layer.	$\text{CCl}_4$ Layer.
0.05	20	30	4
0.10	45	60	8.5
0.15	71	91	13
0.20	100	126	17.5
0.25	130	160	22

A discussion of the results of Jakowkin is given by Schükarew (1901).



DISTRIBUTION OF IODINE BETWEEN CARBON DISULFIDE AND  
AQ. POTASSIUM OXALATE.

(Dawson — Z. physik. Chem. 56, 610, '06; Dawson and McRae — J. Chem. Soc. 81, 1086, '08)

Concentration of Aq. $K_2C_2O_4$ . I.0 Equiv.	Gms. I per Liter of		Vol. of Solution which Contains 1 Mol. I.	Fraction of I Uncombined in Solution.
	Aq. Layer.	$CS_2$ Layer.		
I.0	2.408	10.82	105.3	0.005495
I.0	3.555	16.32	71.37	0.00561
I.0	5.766	27.91	43.99	0.005915
I.0	6.861	34.01	36.98	0.006055
I.2	3.525	17.07	71.97	0.005645

DISTRIBUTION OF IODINE BETWEEN AMYL ALCOHOL AND WATER AND  
BETWEEN AMYL ALCOHOL AND AQUEOUS POTASSIUM IODIDE  
SOLUTIONS AT 25°.

(Herz and Fischer — Ber. 37, 4752, '04.)

The original results were plotted on cross-section paper, and the following tables made from the curves.

Millimols I per 10 cc. Amyl Alcohol Layer in Each Case.	Millimols I per 10 cc. of $H_2O$ and of Aq. KI Layers.					
	$H_2O$ .	$\frac{N}{10}$ KI.	$\frac{2N}{10}$ KI.	$\frac{3N}{10}$ KI.	$\frac{4N}{10}$ KI.	$\frac{5N}{10}$ KI.
2.5	0.012	0.135	0.160	0.170	0.170	...
3.0	0.014	0.150	0.185	0.200	0.200	0.160
4.0	0.018	0.180	0.235	0.255	0.270	0.240
5	0.021	0.210	0.280	0.315	0.340	0.315
6	0.025	0.230	0.330	0.375	0.410	0.390
7	0.029	0.250	0.375	0.430	0.480	0.470
8	...	0.260	0.420	0.490	0.550	0.555
9	...	0.270	0.450	0.550	0.620	0.640
10	...	0.280	0.470	0.605	0.690	0.730
12	...	...	0.490	0.700	0.830	0.900
14	...	...	0.510	0.790	0.980	1.200
20	...	...	0.575	...	...	...

Gms. I per 100 cc. Amyl Alcohol Layer in Each Case.	Gms. I per 100 cc. of $H_2O$ and of KI Layers.					
	$H_2O$ .	$\frac{N}{10}$ KI.	$\frac{2N}{10}$ KI.	$\frac{3N}{10}$ KI.	$\frac{4N}{10}$ KI.	$\frac{5N}{10}$ KI.
3	0.014	0.164	0.20	0.21	0.21	...
4	0.016	0.196	0.24	0.26	0.26	0.21
6	0.026	0.252	0.34	0.38	0.40	0.37
8	0.033	0.297	0.43	0.49	0.54	0.51
10	0.040	0.328	0.51	0.61	0.67	0.69
12	...	0.341	0.58	0.73	0.81	0.84
14	...	...	0.60	0.83	0.95	1.00
16	...	...	0.63	0.91	1.09	1.20
18	...	...	0.64	...	...	...
25	...	...	0.71	...	...	...

The original figures for  $5N/10$  and  $10N/10$  KI solutions give practically identical curves.

Results for the distribution of Iodine between  $N/10$  KI solutions the one hand, and mixtures in various proportions of  $C_5H_{12}$  +  $C_6H_6$ ,  $C_5H_{12}CH_3$  +  $CS_2$ ,  $C_6H_6$  +  $C_5H_9CH_3$ ,  $C_6H_6$  + light petroleum,  $CS_2$  + light petroleum,  $CS_2$  +  $CHCl_3$ ,  $CHCl_3$  +  $C_6H_6$ ,  $CCl_4$  +  $CS_2$ , and  $CCl_4$  +  $C_5H_{12}$  on the other hand, are given by Dawson — J. Chem. Soc., 81, 1086, '08.



## DISTRIBUTION OF IODINE BETWEEN WATER AND IMMISCIBLE ORGANIC SOLVENTS.

Results for Water + Carbon Tetrachloride at 18°. (Dawson, 1908.)	Results for Water + Nitrobenzene at 18°. (Dawson, 1908.)	Results for Water + Carbon Disulfide at 15°. (Dawson, 1902.)	Results for Water + Chloroform at 25°. (Hers & Kurzer, 1910.)
Gms. Iodine per Liter.	Gms. Iodine per Liter.	Gms. Iodine per Liter.	Gms. Iodine per Liter.
CCl <sub>4</sub> Layer.	H <sub>2</sub> O Layer. C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub> Layer.	H <sub>2</sub> O Layer. CS <sub>2</sub> Layer.	H <sub>2</sub> O Layer. CHCl <sub>3</sub> Layer.
0.0344	0.00019 0.0333	0.0452 27.85	0.00025 0.0338
0.0443	0.00050 0.0854	0.0486 30.09	0.00120 0.1546
	0.00133 0.2275	0.0486 30.31	0.00184 0.2318
	0.00189 0.3328		0.00259 0.3439
Results for Water + Tetrachlorethylene at 25°. (Hers & Rathmann, '13.)	Results for Water + Tetrachlorethylene at 25°. (Hers & Rathmann, '13.)	Results for Water + Tetrachlorethylene at 25°. (Hers & Rathmann, '13.)	Results for Water + Pentachlorethylene at 25°. (Hers & Rathmann, '13.)
Gms. Iodine per Liter.	Gms. Iodine per Liter.	Gms. Iodine per Liter.	Gms. Iodine per Liter.
CHCl <sub>3</sub> Layer.	H <sub>2</sub> O Layer. CCl <sub>4</sub> Layer.	H <sub>2</sub> O Layer. C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub> Layer.	H <sub>2</sub> O Layer. C <sub>2</sub> HCl <sub>3</sub> Layer.
0.0543	0.00088 0.0653	0.00119 0.1101	0.00092 0.0848
0.0778	0.00127 0.0932	0.00145 0.1247	0.00117 0.1067
0.1275	0.00172 0.1285	0.00159 0.1479	0.00160 0.1434
0.2672	0.00281 0.2161	0.00217 0.2103	0.00204 0.1963

or the distribution of iodine between water and mixtures of CS<sub>2</sub>+CCl<sub>4</sub> is given by Herz and Kurzer, 1910.

or the distribution of iodine between carbon disulfide and aqueous solutions of the following iodides at 25° are given by van Name and Brown, cadmium iodide, cadmium potassium iodide, lanthanum iodide, nickel potassium iodide, zinc iodide and zinc potassium iodide. Results for the distribution of iodine between carbon tetrachloride and aq. mercuric potassium are also given.

for distribution between CS<sub>2</sub> and aq. BaI<sub>2</sub> sols. are given by Herz and Kurzer, 1910.

or the distribution of iodine between carbon disulfide and aqueous solutions of potassium iodide at 15° and at 13.5°, and between carbon disulfide and solutions of hydriodic acid at 13.5°, are given by Dawson, 1901 and 1902. or the distribution of iodine between carbon tetrachloride and aqueous solutions of mercuric bromide and of mercuric chloride at 25° are given by Herz and Kurzer, 1914.

## DISTRIBUTION OF IODINE BETWEEN CARBON DISULFIDE AND AQ.

ETHYL ALCOHOL AT 25°. (Osaka, 1903-08.)

Gms. Iodine per Liter:			Gms. C <sub>2</sub> H <sub>5</sub> OH per 100 cc. Aq. Alcohol.	Gms. Iodine per Liter:		
CS <sub>2</sub> Layer	Aq. Alcohol Layer c.	$\frac{c}{c'}$		CS <sub>2</sub> Layer	Aq. Alcohol Layer c.	$\frac{c}{c'}$
0.072	35.86	0.0020	19.1	0.330	97	0.0034
0.211	107.79	0.0020	22.9	0.115	23.78	0.0048
0.077	32.93	0.0023	22.9	0.418	89.61	0.0047
0.280	133.22	0.0021	26.7	0.0756	9.8	0.0077
0.075	25.61	0.0029	26.7	0.495	65.10	0.0076
0.315	115.34	0.0027	30.5	0.0636	4.90	0.0130
0.045	13.42	0.0034	30.5	0.546	42.27	0.0129

## DISTRIBUTION OF IODINE BETWEEN ETHER AND ETHYLENE GLYCOL. (Landau, 1910.)

Results at 0°.	Results at 25°.
Gms. Iodine per Liter:	Gms. Iodine per Liter:
(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O Layer (a).	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O Layer (a).
2.139	1.449
7.820	4.347
5.620	9.486
9.564	11.685
1.785	18.135
9.950	44.460
	78.195
	44.460



DISTRIBUTION OF IODINE BETWEEN GLYCEROL AND BENZENE AND BETWEEN GLYCEROL AND CARBON TETRACHLORIDE.  
(Landau, 1910.)

Results for Glycerol and Benzene.				Results for Glycerol and (			
t°.	Grams Iodine per Liter:		(b) (a)	t°.	Gms. Iodine per Liter:		(b) (a)
	Glycerol Layer. (a)	Benzene Layer. (b)			Glycerol Layer. (a)	CCl <sub>4</sub> Layer. (b)	
25°	0.407	1.022	4.72	25°	0.365	0.565	
"	0.676	4.086	6.04	"	0.684	1.224	
"	1.470	10.212	6.95	"	1.416	2.652	
"	2.622	20.102	7.67	"	5.064	9.888	
"	5.280	42.458	8.04	"	7.636	14.766	
40°	0.459	2.168	4.72	40°	0.322	0.575	
"	0.658	3.911	5.94	"	0.690	1.169	
"	1.584	11.244	7.10	"	1.224	2.772	
"	3.048	24.104	7.91	"	2.832	6.444	
"	5.564	46.960	8.44	"	6.854	15.410	
50°	0.467	2.194	4.70	50°	0.299	0.653	
"	0.642	3.864	6.02	"	0.570	1.270	
"	1.463	11.196	7.65	"	1.511	3.457	
"	2.391	19.872	8.31	"	2.664	6.468	
"	5.383	46.782	8.69	"	6.348	16.008	

DISTRIBUTION OF IODINE BETWEEN GLYCEROL AND CHLOROFORM

Results at 25°. (Herz & Kurzer, 1910.)				Results at 30°. (Hantzsch & Vagt, 1901.)				Results at Dif. (Hantzsch & Vagt			
Mols. Iodine per 1000 Gms.		c c°.	t°.	Mols. Iodine per Liter:		c c°.	t°.	Mols. I per Liter:		c c°.	t°.
Glycerol Layer c.	CHCl <sub>3</sub> Layer c°.			Glycerol Layer c.	CHCl <sub>3</sub> Layer c°.			Glycerol Layer c.	CHCl <sub>3</sub> Layer c°.		
0.0244	0.0564	0.43		0.00097	0.00172	0.056	0	0.0119	0.017		
0.0397	0.0919	0.43		0.00204	0.00412	0.495	20	0.0084	0.021		
0.0500	0.1151	0.43		0.00418	0.00898	0.465	40	0.0077	0.022		
				0.00782	0.0216	0.362	50	0.0074	0.022		

Data are also given by the above named investigators for the distribution of iodine between aqueous glycerol solutions and chloroform at several temperatures.

DISTRIBUTION OF IODINE BETWEEN GLYCEROL AND ETHYL ETHER  
(Hantzsch & Vagt, 1901.)

t°.	Mols. Iodine per Liter:		c c°.
	Glycerol Layer (c).	Ether Layer (c°).	
0	0.00566	0.0270	0.21
30	0.00544	0.0272	0.20
30	0.00100	0.0051	0.20

FREEZING-POINT DATA (Solubility, see footnote, p. 1) FOR MIXTURES OF IODINE AND OTHER ELEMENTS.

Iodine and Selenium	(Pellini and Pedrina, 1908.)
" " Sulfur	(Olivari, 1908; Smith and Carson, 1908.)
" " Tellurium	(Jaeger and Menke, 1912.)
" " Tin	(van Klooster, 1912-13; Remders and de Lang, 1913.)

SOLUBILITY OF IODINE IN ARSENIC TRICHLORIDE. (Sloan and Mallet,

t°.	0°.	15°.	30°.
Gms. I per 100 gms. AsCl <sub>3</sub>	8.42	11.88	36.0



**IOSIN** (Sodium tetra iodo fluorescein)  $C_{20}H_8I_4O_5Na$ .

gms.  $H_2O$  dissolve 90 gms. iodo eosin at 20–25°.

(Dehn, 1917.)

gms. pyridine dissolve 4.63 gms. iodo eosin at 20–25°.

"

gms. aq. 50% pyridine dissolve 71.6 gms. iodo eosin at 20–25°.

"

**ORM  $CHI_3$ , IODOL  $C_4I_4NH$**  (Tetraiodopyrrol).

SOLUBILITY IN SEVERAL SOLVENTS.

(U. S. P. VIII; Vulpius, 1893.)

Solvent.	t°.	Gms. per 100 Gms. Solvent.	
		$CHI_3$ .	$C_4I_4NH$ .
ter	25	0.0106	0.0204
hol	25	2.14 (1.43 gms. (V.))	11.1
hol	b. pt.	(10 gms. (V.))	...
er	25	19.2 (16.6 gms. (V.))	66.6
oroform	25	...	0.95
idine	20–25	173.1 (Dehn, 1917.)	
50% pyridine	20–25	22.4	
olin (30% $H_2O$ )	46	5.2 (Klose, 1907.)	

**M CHLORIDE  $IrCl_3$ .**

1 gm. iridium as chloride is dissolved in 100 cc. of 10%  $HCl$  and shaken with 100 cc. of ether, 0.02 per cent of the metal enters the ethereal layer. 10%  $HCl$  is used 5% of the metal enters the ether. When dissolved in 1%  $H_2O$  water approximately 0.01 per cent of the metal enters the ethereal layer.

(Mylus, 1911.)

**M Ammonium CHLORIDE  $IrCl_3 \cdot 2NH_4Cl$ .**

SOLUBILITY IN WATER.

(Rimbach and Korten, 1907.)

t°.	Gms. $IrCl_3 \cdot 2NH_4Cl$ per 100 Gms.		t°.	Gms. $IrCl_3 \cdot 2NH_4Cl$ per 100 Gms.	
	Water.	Sat. Sol.		Water.	Sat. Sol.
4.4	0.699	0.694	52.2	1.608	1.583
16.8	0.905	0.899	61.2	2.130	2.068
19.4	1.226	1.124	69.3	2.824	2.746

**UM DOUBLE SALTS.**

SOLUBILITY IN WATER.

(Palmaer — Ber. 23, 3817; 24, 2090, '91.)

Double Salt.	Formula.	t°.	Gms. per 100 Gms. $H_2O$ .
Pentamine Bromide	$Ir(NH_2)_5Br_3$	12.5	0.284
" Bromonitrate	$Ir(NH_2)_5Br(NO_3)_2$	18	5.58
" Tri Chloride	$Ir(NH_2)_5Cl_3$	15.1	6.53
" Chloro Bromide	$Ir(NH_2)_5ClBr_2$	15	0.47
" Chloro Iodide	$Ir(NH_2)_5ClI_2$	15	0.95
" Chloro Nitrate	$Ir(NH_2)_5Cl(NO_3)_2$	15.4	1.94
" Chloro Sulphate	$Ir(NH_2)_5ClSO_4 \cdot 2H_2O$	15.0	0.74
" Nitrate	$Ir(NH_2)_5(NO_3)_3$	16	0.28
Aquo Pentamine Bromide	$Ir(NH_2)_5(OH_2)Br_3$	ord. temp.	25.0
" " Chloride	$Ir(NH_2)_5(OH_2)Cl_3$	ord. temp.	74.7
" " Nitrate	$Ir(NH_2)_5(OH_2)(NO_3)_3$	17	10.0

**W BROMIDE (Ferrous)  $FeBr_2 \cdot 6H_2O$ .**

SOLUBILITY IN WATER.

(Etard — Ann. chim. phys. [7] 2, 537, '94.)

t°.	Gms. $FeBr_2$ per 100 Gms. Sol.	t°.	Gms. $FeBr_2$ per 100 Gms. Sol.	t°.	Gms. $FeBr_2$ per 100 Gms. Sol.
-20	47.0	30	55.0	60	59.0
0	50.5	40	56.2	80	61.5
20	53.5			100	64.0



## IRON CARBONATE

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### IRON CARBONATE (Ferrous) $\text{FeCO}_3$

SOLUBILITY OF FERROUS CARBONATE IN AQUEOUS SALT SOLUTIONS WITH AND WITHOUT THE PRESENCE OF CARBON DIOXIDE (Ehlert and Hempel, 1912.)

(Each mixture was 1000 cc. in volume and was rotated constantly at a temperature of probably 5-8°.)

Aqueous Solution of:	SOLUBILITY IN PRESENCE OF $\text{CO}_2$ (2 atmospheres pressure).		SOLUBILITY OF
	Gms. Salt per 1000 Gms. $\text{H}_2\text{O}$ .	Gms. $\text{FeCO}_3$ per 1000 cc. Solvent.	Gms. Salt per 1000 Gms. $\text{H}_2\text{O}$
Water alone	0	6.191	...
NaCl	...	...	351.2
$\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$	86.9	5.840	...
"	700	4.555	...
"	1150	4.459	...
"	1437.5	4.693	...
"	1725	5.398	...
"	2300	9.052	2300
$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$	137.7	7.943	137.7
"	Sat. at 14°	9.578	Sat. at 14
$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	105.3	6.242	105.3
"	Sat. at 14°	7.392	Sat. at 14

### IRON BICARBONATE (Ferrous) $\text{Fe}(\text{HCO}_3)_2$

SOLUBILITY OF FERROUS BICARBONATE IN CARBONATED WATER (Smith, H. J., 1918.)

Pure white ferrous carbonate was prepared by heating to redness in a steel bottle, an aqueous solution of ferrous sulfate, so and carbon dioxide (introduced at 400 lbs. pressure). The product was similar to the mineral siderite and was probably isomorphous with it. Fifty to one hundred gram portions were placed in a two-liter steel bottle on the inside with a mixture of beeswax and Venice turpentine. and  $\text{CO}_2$  introduced through a needle valve from a cylinder of carbon dioxide. The pressure was read on a gauge. The bottle was rotated at a constant rate for several days or until equilibrium was reached. The saturated solution for analysis was withdrawn through a brass tube at the valve on the inside of the bottle and packed with cotton to avoid the loss of  $\text{CO}_2$ . The portion was received in a tared evacuated flask, containing conc.  $\text{H}_2\text{SO}_4$ . The  $\text{CO}_2$  was determined by absorption and the iron by reduction, reduction and titration with permanganate. The decomposition tension of  $\text{Fe}(\text{HCO}_3)_2$  is greater than 25 atm.

Gms. Mols. per Liter.		Gms. per Liter.		Gms. Mols. per Liter.	
$\text{H}_2\text{CO}_3$	$\text{Fe}(\text{HCO}_3)_2$	$\text{H}_2\text{CO}_3$	$\text{Fe}(\text{HCO}_3)_2$	$\text{H}_2\text{CO}_3$	$\text{Fe}(\text{HCO}_3)_2$
0.1868	0.00245	11.58	0.436	0.3294	0.00311
0.1985	0.00256	12.31	0.455	0.3745	0.00315
0.2168	0.00262	13.45	0.466	0.4046	0.00332
0.2327	0.00274	14.43	0.487	0.4750	0.00348
0.2960	0.00303	18.35	0.539	0.6600	0.00402
0.3116	0.00304	19.32	0.541	0.7154	0.00418
0.3153	0.00318	19.55	0.566	0.7600	0.00434

### IRON CHLORIDE (Ferrous) $\text{FeCl}_2 \cdot 4\text{H}_2\text{O}$

100 gms. sat. sol. in water contain 17.54 gms. Fe = 39.82 gms  
100 gms. sat. sol. in water contain 18.59 gms. Fe = 42.8 gms



**IRON CHLORIDE (Ferrous)  $\text{FeCl}_2 \cdot 4\text{H}_2\text{O}$ . SOLUBILITY IN WATER.**  
(Etard.)

t°.	Gms. $\text{FeCl}_2$ per 100 Gms. Solution.	Solid Phase.	t°.	Gms. $\text{FeCl}_2$ per 100 Gms. Solution.	Solid Phase.
20	39.2	$\text{FeCl}_2 \cdot 4\text{H}_2\text{O}$	60	47.0	$\text{FeCl}_2 \cdot 4\text{H}_2\text{O}$
15	40.0	"	80	50.0	"
35	41.5	"	87	51.2	$\text{FeCl}_2 \cdot 4\text{H}_2\text{O} + \text{FeCl}_2$
30	42.2	"	90	51.3	$\text{FeCl}_2$
40	43.6	"	100	51.4	"
50	45.2	"	120	51.8	"

**SOLUBILITY OF IRON CHLORIDE (FERRIC)  $\text{Fe}_2\text{Cl}_6$  IN WATER.**  
(Roeseboom — Z. physik. Chem. 10, 477, '92.)

t°.	Mols. $\text{Fe}_2\text{Cl}_6$ per 100 Mols. $\text{H}_2\text{O}$ .		Gms. $\text{Fe}_2\text{Cl}_6$ per 100 Gms.		t°.	Mols. $\text{Fe}_2\text{Cl}_6$ per 100 Mols. $\text{H}_2\text{O}$ .		Gms. $\text{Fe}_2\text{Cl}_6$ per 100 Gms.	
	Solution.		Solution.			Solution.		Solution.	
Solid Phase, $\text{Fe}_2\text{Cl}_6 \cdot 12\text{H}_2\text{O}$ .					Solid Phase, $\text{Fe}_2\text{Cl}_6 \cdot 5\text{H}_2\text{O}$ (con.).				
-55	2.75	49.52	33.12		35	15.64	281.6	73.79	
-27	2.98	53.60	34.93		50	17.50	315.2	75.91	
0	4.13	74.39	42.66		55	19.15	344.8	77.52	
+20	5.10	91.85	47.88		55	20.32	365.9	78.54	
30	5.93	106.8	51.64		Solid Phase, $\text{Fe}_2\text{Cl}_6 \cdot 4\text{H}_2\text{O}$ .				
37	8.33	150.0	60.01		50	19.96	359.3	78.23	
30	11.20	201.7	66.85		55	20.32	365.9	78.54	
20	12.83	231.1	69.79		60	20.70	372.8	78.86	
8	13.7	246.7	71.15		69	21.53	387.7	79.50	
Solid Phase, $\text{Fe}_2\text{Cl}_6 \cdot 7\text{H}_2\text{O}$ .					73.5	25.0	450.2	81.81	
20	11.35	204.4	67.14		70	27.9	502.4	83.41	
32	13.55	244.0	70.92		66	29.2	525.9	84.03	
30	15.12	272.4	73.13		Solid Phase, $\text{Fe}_2\text{Cl}_6$ .				
25	15.54	280.0	73.69		66	29.2	525.9	84.03	
Solid Phase, $\text{Fe}_2\text{Cl}_6 \cdot 5\text{H}_2\text{O}$ .					75	28.92	511.4	83.66	
12	12.87	231.8	69.87		80	29.20	525.9	84.03	
27	14.85	267.5	72.78		100	29.75	535.8	84.26	

**SOLUBILITY OF FERRIC CHLORIDE IN AQUEOUS SOLUTIONS OF  
AMMONIUM CHLORIDE AT 25°, 35°, AND 45°.**  
(Mohr — Z. physik. Chem. 27, 197, '98.)

Results at 25°. Results at 35°. Results at 45°.

Mols. per 100 Mols. $\text{H}_2\text{O}$ .	Mols. per 100 Mols. $\text{H}_2\text{O}$ .		Mols. per 100 Mols. $\text{H}_2\text{O}$ .		Solid Phase in Each Case.
	$\text{NH}_4\text{Cl}$ .	$\text{FeCl}_3$ .	$\text{NH}_4\text{Cl}$ .	$\text{FeCl}_3$ .	
0	10.98	0	13.36	0.0	$\text{Fe}_2\text{Cl}_6 \cdot 12\text{H}_2\text{O}$ (5. $\text{H}_2\text{O}$ at 45°)
1.57	10.74	1.41	13.05	...	Hydrate + Double Salt
2.48	9.02	3.08	9.28	4.08	Double Salt
5.28	7.73	6.98	7.64	...	"
9.59	6.77	10.76	6.70	13.09	"
9.83	6.70	11.60	6.52	13.54	Double Salt + Mixed Crystals
9.65	6.07	12.28	6.08	12.91	Mixed Crystals
9.93	5.23	11.57	3.98	13.49	"
9.92	3.97	11.89	3.38	13.46	"
10.31	2.05	13.23	1.38	...	"
13.30	0.0	14.79	0.0	16.28	$\text{NH}_4\text{Cl}$



SOLUBILITY OF FERRIC CHLORIDE IN AQUEOUS SOLUTIONS  
AMMONIUM CHLORIDE AT 15°.  
(Roozeboom — Z. physik. Ch. 10, 148, '92.)

Mols. per 100 Mols. H <sub>2</sub> O.		Grams per 100 Gms. H <sub>2</sub> O.		Solid Phase.
NH <sub>4</sub> Cl.	FeCl <sub>3</sub> .	NH <sub>4</sub> Cl.	FeCl <sub>3</sub> .	
0.0	9.30	0.0	83.88	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O
1.09	9.57	3.24	86.32	"
1.36	9.93	4.03	91.61	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O + Double Salt
2.00	9.27	5.92	83.64	Double Salt
2.79	8.71	8.31	78.77	"
4.05	8.09	12.08	73.20	"
6.41	7.18	19.12	64.83	"
10.78	6.21	32.04	56.00	"
7.82	6.75	23.21	60.83	Mixed Crystals containing 7.95% FeCl
7.62	5.94	22.63	53.47	" " 5.55 "
7.70	5.03	22.90	45.42	" " 4.4 "
7.81	4.34	23.23	39.13	" " 3.8 "
8.52	2.82	25.33	25.43	" " 1.64 "
10.95	0.68	32.55	6.15	" " 0.31 "
11.88	0.0	35.30	0.0	NH <sub>4</sub> Cl

SOLUBILITY OF FERRIC CHLORIDE IN AQUEOUS HYDROCHLORIC A.  
SOLUTIONS AT DIFFERENT TEMPERATURES.  
(Roozeboom and Schreinemaker — Z. physik. Chem. 15, 633, '94.)

Mols. per 100 Mols. H <sub>2</sub> O.		Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.	Mols. per 100 Mols. H <sub>2</sub> O.		Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.
HCl.	FeCl <sub>3</sub> .	HCl.	FeCl <sub>3</sub> .		HCl.	FeCl <sub>3</sub> .	HCl.	FeCl <sub>3</sub> .	
Results at 0°.					Results at 25° (con.).				
0	8.25	0	74.30	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O	0.0	29.00	0.0	261.1	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O
7.52	6.51	15.22	58.62		7.5	29.75	15.18	267.9	
13.37	6.33	27.06	57.01		19.5	35.25	39.46	317.4	
16.80	8.70	33.99	78.34		19.5	35.25	39.46	317.4	
18.45	10.23	37.34	92.10		20.6	35.34	41.68	318.3	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O
20.40	15.40	41.28	138.7		31.34	41.58	63.42	374.4	
20.10	16.00	40.67	144.1		33.00	43.00	66.77	387.3	
19.95	17.70	40.37	159.4		34.65	44.80	70.11	403.4	
19.00	22.75	38.45	204.8		40.41	40.25	81.77	362.4	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O +
18.05	23.41	36.53	210.8		39.03	41.38	78.98	372.7	
18.05	23.40	36.53	210.8		35.74	45.24	72.33	407.4	
19.50	25.93	39.55	233.5						
Results at 40°.					Results at 40°.				
24.12	30.04	48.81	270.5	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O	0	32.4	0.0	291.7	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O
26.00	32.16	52.60	289.6		13.4	37.45	27.11	337.3	
26.00	32.16	52.60	289.6		13.4	37.45	27.11	337.3	
34.60	38.11	70.01	343.2		27.0	50.80	54.64	457.5	
37.27	36.60	75.41	329.6	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O + 4HCl	0	58.0	0.0	522.3	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O
34.60	38.11	70.01	343.2		27	50.8	54.64	457.5	
Results at 25°.					Results at 25°.				
0.0	10.90	0.0	98.15	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O	42.01	48.64	85.00	438.0	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O + 4HCl
2.33	23.72	4.715	213.6		42.50	47.52	86.72	428.0	
0.0	24.5	0.0	220.7		42.01	48.64	85.00	438.0	
0.0	23.5	0.0	211.6						
2.33	23.72	4.715	213.4	Fe <sub>2</sub> Cl <sub>6</sub> ·12H <sub>2</sub> O	Results for other temperatures are also given in the original paper.				
7.50	29.75	15.18	267.9						
0.0	31.50	0.0	283.6						



FOR THE SYSTEM FERRIC OXIDE, HYDROCHLORIC ACID, WATER AT 25°.  
(Cameron and Robinson, 1907.)

As of ferric hydroxide was added to aq. ferric chloride solutions and agitated 3 months.)

Gms. per 100 Gms. Sat. Sol.	Solid Phase.	$d_m$ of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
			Fe <sub>2</sub> O <sub>3</sub> .	HCl.	
HCl					
59.88	FeCl <sub>3</sub> ·HCl·2H <sub>2</sub> O	1.485	21.84	29.33	{ FeCl <sub>3</sub> ·6H <sub>2</sub> O + Fe <sub>2</sub> O <sub>3</sub> ·2HCl·H <sub>2</sub> O
60.23	"	1.349	16.82	22.55	
54.71	" + FeCl <sub>3</sub>	1.321	15.83	21.10	"
58.20	FeCl <sub>3</sub> + FeCl <sub>3</sub> ·2H <sub>2</sub> O	1.284	14.62	19.53	"
54.12	FeCl <sub>3</sub> ·2H <sub>2</sub> O	1.242	12.59	16.61	"
59.28	"	1.220	11.76	15.28	"
55.71	"	1.195	10.56	13.76	"
55.47	" + FeCl <sub>3</sub> ·2H <sub>2</sub> O	1.158	8.60	11.24	"
51.11	FeCl <sub>3</sub> ·3H <sub>2</sub> O + "	1.115	6.47	8.39	"
46.72	" + FeCl <sub>3</sub> ·6H <sub>2</sub> O	1.070	4.04	5.36	"
33.40	FeCl <sub>3</sub> ·6H <sub>2</sub> O	1.047	2.85	3.66	"

for the systems FeCl<sub>3</sub> + MgCl<sub>2</sub> + KCl + H<sub>2</sub>O at 22.8° and for FeCl<sub>3</sub> + NaCl are given by Boeke, 1911.

anhyd. acetone dissolve 62.9 gms. FeCl<sub>3</sub> at 18°. (Naumann, 1904.)

anhydrous lanolin (m. pt. about 46°) dissolve 4.17 gms. FeCl<sub>3</sub> at 45°. (Klose, 1907.)

#### SOLUBILITY OF FERRIC CHLORIDE BETWEEN WATER AND ETHER AT 18°. (Mylus, 1911.)

Equal portions of iron as chloride were dissolved in 100 cc. of aq. HCl of various concentrations and shaken with 100 cc. of ether in each case. The percentage of iron in the ethereal layer was determined after separation of the two

Percent conc. of Aq. HCl	1	5	10	15	20
Percent of Iron Extracted by Ether	(0.01)	0.1	8	92	99

Phase diagrams (solubility, see footnote, p. 1) for mixtures of FeCl<sub>3</sub> + PbCl<sub>2</sub>, FeCl<sub>3</sub> + ZnCl<sub>2</sub> are given by Herrmann, 1911, and for mixtures of FeCl<sub>3</sub> + TiCl<sub>3</sub> by Herrmann, 1912.

#### SOLUBILITY OF THE SALT PAIR FeCl<sub>3</sub>·NaCl IN WATER AT 21°. (Hinrichsen and Sachsel, 1904-05.)

Gms. Used.	Gms. per 100 Gms. Solution.		G. Mols. per 100 Mols. H <sub>2</sub> O.		Solid Phase.
	FeCl <sub>3</sub> .	NaCl.	FeCl <sub>3</sub> .	NaCl.	
NaCl.					
3.6	0	36.10	0	11.2	NaCl
3	24.27	9.10	2.69	2.8	Mix Crystals
2.5	25.40	8.45	2.81	2.6	"
2	26.40	5.25	2.93	2.54	"
1.5	38.15	3.90	4.23	1.22	"
1	45.38	2.45	5.03	0.75	"
0.5	46.75	2.11	5.18	0.65	"
0	83.39	0	9.3	0	FeCl <sub>3</sub>



# IRON CHLORIDE

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## SOLUBILITY OF THE SALT PAIR $\text{FeCl}_3$ , $\text{KCl}$ IN WATER AT (Hinrichsen and Sachsel, 1904-05.)

Gms. Used.		Gms. per 100 Gms. Solution.		Gms. Mols. per 100 Mols. $\text{H}_2\text{O}$ .		Sol
$\text{FeCl}_3$	$\text{KCl}$	$\text{FeCl}_3$	$\text{KCl}$	$\text{FeCl}_3$	$\text{KCl}$	
0	35	0	34.97	0	8.45	Mix
13	28	13.44	24.45	1.49	5.90	
18	21	23.18	16.54	2.57	3.99	
23	18.5	28.05	11.69	3.11	2.82	
28	16	35.72	11.68	3.96	2.82	$\text{FeCl}_3$
31	10.5	36.62	11.19	4.06	2.70	
36.2	9	37.35	13.67	4.14	3.30	
46.5	6	51.69	7.54	5.73	1.82	
155	0	83.89	0	9.3	0	

## SOLUBILITY OF THE SALT PAIR $\text{FeCl}_3$ , $\text{CsCl}$ IN WATER AT (H. and S.)

Gms. Used.		Gms. per 100 Gms. Solution.		Gms. Mols. per 100 Mols. $\text{H}_2\text{O}$ .		Sol
$\text{FeCl}_3$	$\text{CsCl}$	$\text{FeCl}_3$	$\text{CsCl}$	$\text{FeCl}_3$	$\text{CsCl}$	
0	65	0	65	0	6.95	$\text{FeCl}_3$
0.6	11.6	0.45	55.18	0.05	5.9	
1.4	10.2	2.1	52.38	0.23	5.6	
2.2	8.8	5.24	51.44	0.57	5.5	
2	7.4	7.8	47.70	0.86	5.1	$\text{FeCl}_3$
3.8	6	8.93	41.15	0.99	4.4	
4.6	4.6	15.34	25.25	1.70	2.7	$\text{FeCl}_3$
5.4	2.8	21.65	14.96	2.40	1.6	
6.2	1.4	27.96	8.42	3.10	0.9	
35	0.2	48.71	0.94	5.40	0.1	
35	0	83.89	0	9.3	0	

# IRON FORMATE (Ferric) $\text{Fe}_3(\text{OH})_2(\text{HCOO})_{7.4}\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER AND IN ABSOLUTE ALCOHOL. (Hampshire and Pratt, 1913.)

Solubility in Water.			Solubility in	
t°.	Gms. Salt per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	pt
15	5.08	$\text{Fe}_3(\text{OH})_2(\text{HCOO})_{7.4}\text{H}_2\text{O}$	19	
20	5.52	"	22	
25	6.10	"	23	
30	6.78	"	(The sat. solutions at	
35	7.52	"		



**III HYDROXIDE** (Ferric)  $\text{Fe}(\text{OH})_3$ .**SOLUBILITY OF FERRIC HYDROXIDE IN AQUEOUS OXALIC ACID SOLUTION AT 25°.**

(Cameron and Robinson, 1909.)

The solutions were constantly agitated for 3 months. The solubility is directly proportional to the concentration of the oxalic acid and no definite basic ferric salt is formed.

$d_m$ of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		$d_m$ of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.	
	$\text{Fe}_2\text{O}_3$	$\text{C}_2\text{O}_3$		$\text{Fe}_2\text{O}_3$	$\text{C}_2\text{O}_3$
1.007	0.48	0.61	1.040	2.33	3.10
1.015	0.95	1.23	1.050	2.98	3.85
1.031	1.86	2.45	1.064	3.62	5.17

**IV NITRATE** (Ferric)  $\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ .**EQUILIBRIUM IN THE SYSTEM, FERRIC OXIDE, NITRIC ACID AND WATER AT 25°.**

(Cameron and Robinson, 1909.)

Solutions of ferric nitrate of varying concentrations were shaken with freshly precipitated ferric hydroxide at const. temp., 25°, for 4 months. The acid branch of the curve was studied in a similar manner by starting with ferric nitrate and increasing concentrations of nitric acid. No definite basic nitrates of iron were formed.

# Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	$d_m$ of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	$\text{Fe}_2\text{O}_3$	$\text{N}_2\text{O}_5$			$\text{Fe}_2\text{O}_3$	$\text{N}_2\text{O}_5$	
32	1.78	2.21	$\text{Fe}_2\text{O}_3 \cdot 3\text{N}_2\text{O}_5 \cdot 18\text{H}_2\text{O}$	1.452	12.14	33.5	$\text{Fe}_2\text{O}_3 \cdot 3\text{N}_2\text{O}_5 \cdot 18\text{H}_2\text{O}$
19	3.99	5.61	"	1.434	9.95	36.3	"
17	5.79	9	"	1.417	7.25	40.3	"
17	7.22	12.31	"	1.404	5.02	47.5	"
14	9.70	16.60	"	1.428	3.55	51.5	"
8	12.48	22.70	"	1.450	4.51	52	"
5	14.62	28.13	"	1.465	4.19	55.2	"
8	15.40	29.52	"	1.407	3.93	47.2	$\text{Fe}_2\text{O}_3 \cdot 4\text{N}_2\text{O}_5 \cdot 18\text{H}_2\text{O}^*$
6	15.22	30.50	$\text{Fe}_2\text{O}_3 \cdot 3\text{N}_2\text{O}_5 \cdot 18\text{H}_2\text{O}$	1.419	3.52	49.6	"

\* This salt was obtained accidentally and its preparation could not be repeated.

**V NITRATE** (Ferrous)  $\text{Fe}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ .**SOLUBILITY IN WATER.**

(Funk, 1900.)

Gms. $\text{Fe}(\text{NO}_3)_2$ per 100 Gms. Sol.	Mols. $\text{Fe}(\text{NO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Fe}(\text{NO}_3)_2$ per 100 Gms. Sol.	Mols. $\text{Fe}(\text{NO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
35.66	5.54	$\text{Fe}(\text{NO}_3)_2 \cdot 9\text{H}_2\text{O}$	-9	39.68	6.57	$\text{Fe}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
5 36.10	5.64	"	0	41.53	7.10	"
36.56	5.76	"	18	45.14	8.23	"
5 37.17	5.91	"	24	46.51	8.70	"
			60.5	62.50	16.67	"

Solubility of solution saturated at 18° = 1.497.



## IRON OXALATE

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### IRON OXALATE (Ferrous) $\text{FeC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ .

SOLUBILITY IN WATER AT 25° DETERMINED BY THE CONDUCTIVITY METHOD (Schäfer, 1905.)

The sat. solution contains  $5.38 \cdot 10^{-4}$  gm. mols.  $\text{C}_2\text{O}_4$  per liter.

### IRON OLEATE.

100 gms. glycerol ( $d = 1.114$ ) dissolve 0.71 gm. iron oleate. (As)

### IRON OXIDES, HYDROXIDE and SULPHIDE.

#### SOLUBILITY IN AQUEOUS SUGAR SOLUTIONS.

(Stille—Z. Ver Zuckerind. 50, 340, '00.)

% Sugar in Sol- vent.	One Liter of Sugar Solutions Dissolves Milligrams of:									Fe	
	$\text{Fe}_2(\text{OH})_6$ at:			$\text{Fe}_2\text{O}_3$ at:							
	$\text{Fe}_2\text{O}_3$ at:			$\text{Fe}_2\text{O}_3$ at:							
	17.4°.	45°.	75°.	17.5°.	45°.	17.5°.	45°.	75°.	17.5°.		
10	3.4	3.4	6.1	1.4	2.0	10.3	10.3	12.4	3.8		
30	2.3	2.7	3.8	1.4	...	12.4	10.3	12.4	7.1		
50	2.3	1.9	3.4	0.8	1.1	14.5	10.3	14.5	9.9		

### IRON PHOSPHATE $\text{Fe}_3(\text{PO}_4)_2$ .

#### THE ACTION OF WATER AND OF AQUEOUS SALT SOLUTIONS ON FERRIC PHOSPHATE.

(Lachowicz—Monatsh. Chem. 13, 357, '92; Cameron and Hurst—J. Am. Chem. Soc. 24)

The experiments show that the ordinary precipitation method for the production of ferric phosphate give products which do not correspond to the formula  $\text{Fe}_3(\text{PO}_4)_2$ . By digesting such samples with water very little is dissolved, but the material is decomposed to a certain extent depending upon the relative amounts of solid and solvent used. The amount of  $\text{PO}_4$  dissolved per gram of  $\text{Fe}_3(\text{PO}_4)_2$  varies from 0.0026 gram removed by 5 cc.  $\text{H}_2\text{O}$  to 0.0182 gram removed by 5 cc.  $\text{H}_2\text{O}$  at the ordinary temperature.

#### SOLUBILITY FERRIC PYROPHOSPHATE IN AQ. AMMONIA AT 0°.

(Pasc.) The solutions containing an excess of salt were agitated violently for 24 hours for seven hours and filtered at 0°. The sat. sol. was analyzed for iron and for residue obtained by evaporation.

Gms. $\text{NH}_3$ per 100 Gms. Sat. Sol.	Gms. $\text{Fe}_2(\text{P}_2\text{O}_7)_3$ per 100 Gms. Sat. Sol.	Solid Phase.	Gms. $\text{NH}_3$ per 100 Gms. Sat. Sol.	Gms. $\text{Fe}_2(\text{P}_2\text{O}_7)_3$ per 100 Gms. Sat. Sol.	Solid
0.884	5.606	$\text{Fe}_2(\text{P}_2\text{O}_7)_3$	5.92	14.71	viscous bl
1.59	9.75	"	8.26	13.89	chamois c
3.71	14.85	"	10.55	7.40	
4.72	15.94	"	15.96	2.52	
5.93	13.92	viscous black deposit	18.83	0.445	
7.91	14.61	"			

#### SOLUBILITY OF FERRIC PHOSPHATE IN AQ. PHOSPHORIC ACID SOLUTIONS

(Cameron and Bell, 1907.)

Solid ferric phosphate of unknown composition was constantly agitated in aq. phosphoric acid solutions of concentrations up to 5% for 4 months. The compositions of the sat. solutions and solid phases were made.

$d_{25}$ of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	$\text{Fe}_2\text{O}_3$	$\text{P}_2\text{O}_5$	
1.0074	0.0105	0.942	Solid Solution
1.0162	0.0205	1.084	"
1.0244	0.0384	2.838	"
1.0310	0.0611	3.770	"
1.0383	0.0849	4.706	"



IRON SULFATE (Ferrous)  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ .

## SOLUBILITY OF FERROUS SULFATE IN WATER. (Fraenckel, 1907.)

t°.	Gms. $\text{FeSO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{FeSO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
-0.172	1.0156	Ice	45.18	44.32	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$
-0.566	4.2852	"	50.21	48.60	"
-1.063	8.7054	"	52	50.20	"
-1.511	12.713	"	54.03	52.07	"
-1.771	14.511	"	56.56 tr. pt.	54.58	" + $\text{FeSO}_4 \cdot 4\text{H}_2\text{O}$
-1.82 Eutec.	17.53	Ice + $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$	60.01	54.95	$\text{FeSO}_4 \cdot 4\text{H}_2\text{O}$
0	15.65	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$	65	55.59	" unstable
+10	20.51	"	70.04	56.08	" "
15.25	23.86	"	64.8 tr. pt.	...	$\text{FeSO}_4 \cdot 4\text{H}_2\text{O}$ + $\text{FeSO}_4 \cdot \text{H}_2\text{O}$
20.13	26.56	"	68.02	52.31	$\text{FeSO}_4 \cdot \text{H}_2\text{O}$
25.02	29.60	"	77	45.90	"
30.03	32.93	"	80.41	43.58	"
35.07	36.87	"	85.02	40.46	"
40.05	40.20	"	90.13	37.27	"

 $d_{44}$  of sat. sol. = 1.219]

(Greenish and Smith, 1903.)

## SOLUBILITY OF FERROUS SULFATE IN AQ. SOLUTIONS OF LITHIUM SULFATE AT 30°. AND VICE VERSA. (Schreinemakers, 1910.)

Gms. per 100 Gms. Sat. Sol.:			Gms. per 100 Gms. Sat. Sol.		
$\text{FeSO}_4$	$\text{Li}_2\text{SO}_4$	Solid Phase.	$\text{FeSO}_4$	$\text{Li}_2\text{SO}_4$	Solid Phase.
24.87	0	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$	15.39	16.80	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
24.45	4	"	12.68	18.31	"
21.15	5.58	"	5.32	22.15	"
18.79	11.16	"	3.74	23.15	"
16.51	15.81	"	0	25.1	"
16.11	16.50	" + $\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$			

## EQUILIBRIUM IN THE SYSTEM FERRIC OXIDE, SULFURIC ACID AND WATER AT 25°. (Cameron and Robinson, 1907.)

(Excess of freshly precipitated ferric hydroxide was added to ferric sulfate solutions of varying concentrations and the mixtures constantly shaken for 4 months.)

$d_4$ of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	$\text{Fe}_2\text{O}_3$	$\text{SO}_3$		$\text{Fe}_2\text{O}_3$	$\text{SO}_3$	
1.001	0.07	0.11	Solid Solution	20.48	26.18	$\text{Fe}_2\text{O}_3 \cdot 3\text{SO}_3 \cdot 10\text{H}_2\text{O}$
1.011	0.62	0.94	"	19.77	28.93	"
1.045	2.03	2.65	"	10.87	31.35	$\text{Fe}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot 10\text{H}_2\text{O}$
1.131	6.18	7.40	"	0.16	35.96	"
1.217	10.03	11.84	"	0.07	41.19	"
1.440	15.90	20.70	"	1.05	42.43	"

## SOLUBILITY OF FERRIC SULFATE AND OF FERROUS SULFATE IN AQ. SOLUTIONS OF SULFURIC ACID AT 25°. (Wirth, 1912-13.)

## Results for Ferric Sulfate.

Normality of used Acid.	Gms. per 100 Gms. Sat. Sol.	
	$\text{Fe}_2\text{O}_3$	$\text{Fe}_2(\text{SO}_4)_3$
2.25	9.99	25.02
6.685	5.82	14.58
19.84	0.02	0.05

## Results for Ferrous Sulfate.

Normality of used Acid.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	$\text{Fe}_2\text{O}_3$	$\text{FeSO}_4$	
2.25	10	19.03	$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$
10.2	5.414	10.30	"
12.46	3.816	7.26	$\text{FeSO}_4 \cdot \text{H}_2\text{O}$
15.15	2.11	4.015	"
19.84	0.08	0.1522	"



EQUILIBRIUM IN THE SYSTEM FERRIC OXIDE-SULFUR TRIOXIDE-WATER A  
(Wirth and Bakke, 1914.)

(The mixtures were shaken for 3-4 weeks.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase
Fe <sub>2</sub> O <sub>3</sub> .	SO <sub>3</sub> .		Fe <sub>2</sub> O <sub>3</sub> .	SO <sub>3</sub> .	
...	71.23	not det.	14.49	31.45	unstable
0.24	56.84	"	15.71	31.88	"
3.53	34	{ prob. Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> .H <sub>2</sub> SO <sub>4</sub> .9H <sub>2</sub> O + Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> .H <sub>2</sub> SO <sub>4</sub> .3H <sub>2</sub> O	20.21	31.30	"
6.65	32.15		9.39	31.54	{ Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> .H <sub>2</sub> SO <sub>4</sub> .8H <sub>2</sub> O Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> .9H <sub>2</sub> O
9.39	31.54	" + Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> .H <sub>2</sub> SO <sub>4</sub> .3H <sub>2</sub> O	11.06	29.43	Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> .9H <sub>2</sub> O
12.03	31.51	Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> .H <sub>2</sub> SO <sub>4</sub> .8H <sub>2</sub> O	13.88	28.33	"
13.27	31.84	"	15.23	27.92	"
13.68	31.78	unstable	16.07	27.98	"

Results are also given for the two forms of yellow ferric sulfate ( $\alpha$  copiapite  $\beta$  copiapite) also for ferric hydroxide and sulfate solutions.

It was found that a saturated solution of Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>.H<sub>2</sub>SO<sub>4</sub>.8H<sub>2</sub>O in abs. at 25° contained 8 gms. Fe<sub>2</sub>O<sub>3</sub> + 17.18 gms. SO<sub>3</sub> (Ratio, 1:4.235) per 100 gr sol.

The yellow ferric sulfate Fe<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>.9H<sub>2</sub>O is less soluble in alcohol. / weeks shaking at 25°, 100 gms. of the sat. solution in abs. alcohol contained gms. Fe<sub>2</sub>O<sub>3</sub> and 6.779 gms. SO<sub>3</sub> (Ratio, 1:3.006). Thus the alcoholic sol just as the aqueous, is considerably more acid than the solid phase with w is in equilibrium.

100 grams sat. solution in glycol contain 6 gms. FeSO<sub>4</sub> at ordinary tempe

100 gms. anhydrous hydrazine dissolve 1 gm. ferrous sulfate at room (de l with decomposition. (Welsh and Brodersen

SOLUBILITY OF MIXTURES OF FERROUS SULPHATE FeSO<sub>4</sub>.7H<sub>2</sub>O  
SODIUM SULPHATE Na<sub>2</sub>SO<sub>4</sub>.10H<sub>2</sub>O IN WATER.

(Koppel—Z. physik. Chem. 52, 405, '05.)

t°.	Gms. per 100 Gms. Solution.		Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.
	FeSO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	FeSO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	
0	14.54	4.93	18.06	6.11	FeSO <sub>4</sub> .7H <sub>2</sub> O + Na <sub>2</sub> SO <sub>4</sub> .10H <sub>2</sub> O
15.5	17.76	11.32	25.05	15.97	"
21.8	16.57	15.32	24.34	22.51	FeNa <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> .4H <sub>2</sub> O
24.92	16.21	15.13	23.62	22.04	"
35	16.35	14.98	23.91	21.83	"
40	16.37	15.42	24.01	22.62	"
18.8	18.13	13.8	26.63	20.28	FeNa <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> .4H <sub>2</sub> O + FeSO <sub>4</sub> .
23	19.58	12.5	28.82	18.4	"
27	20.97	11.3	30.95	16.64	"
31	22.91	9.71	33.99	14.41	"
35	23.85	9.26	35.66	13.85	"
40	26.32	7.85	39.98	11.92	"
18.8	18.23	14.83	27.23	22.16	FeNa <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> .4H <sub>2</sub> O + Na <sub>2</sub> SO <sub>4</sub>
23	13.83	18.04	20.31	26.48	"
28	7.66	24.41	11.28	35.94	"
31	4.58	29.50	6.95	44.75	"
35	4.04	30.49	6.16	46.58	FeNa <sub>2</sub> SO <sub>4</sub> .4H <sub>2</sub> O + Na <sub>2</sub> SO <sub>4</sub>
40	4.10	30.60	6.27	46.99	"



**IRON Potassium SULFATE (Ferrous)  $\text{FeSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ .**

SOLUBILITY IN WATER. (Tobler, 1855.)

t°.	Gms. $\text{K}_2\text{Fe}(\text{SO}_4)_2$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{K}_2\text{Fe}(\text{SO}_4)_2$ per 100 Gms. $\text{H}_2\text{O}$ .
0	19.6	35	41
10	24.5	40	45
14.5	29.1	55	56
16	30.9	65	57.3
25	36.5	70	64.2

**IRON SULFIDE (Ferrous)  $\text{FeS}$ .**

One liter of water, saturated at 18° with precipitated ferrous sulfide, contains  $7.1 \cdot 10^{-4}$  mols.  $\text{FeS} = 0.00616$  gm., determined by conductivity method.

(Weigel, 1906, 1907.)

Additional data for the solubility in water are given by Bruner and Zawadzki. 100 gms. anhydrous hydrazine dissolve 9 gms.  $\text{FeS}$  at room temp. with decomposition.

(Welsh and Brodersen, 1915.)

Fusion diagrams for mixtures of  $\text{FeS} + \text{PbS}$  and for  $\text{FeS} + \text{ZnS}$  are given by Friedrich, 1907, 1908.

**IRON SULFONATES.**

SOLUBILITY OF IRON PHENANTHRENE SULFONATES IN WATER AT 20°.

(Sandquist, 1912.)

Salt.		Gms. Anhydrous Salt per 100 Gms. $\text{H}_2\text{O}$ .
Iron 2-Phenanthrene Monosulfonate	$5\text{H}_2\text{O}$	0.044
" 3- "	$5\text{H}_2\text{O}$	0.20
" 10- "	$6\text{H}_2\text{O}$	0.16

**IRON THIOCYANATE (Ferric)  $\text{Fe}(\text{CNS})_3 \cdot 3\text{H}_2\text{O}$ .**

DISTRIBUTION BETWEEN WATER AND ETHER. (Hantzsch and Vagt, 1901.)

Results at 25°.				Results at Several Temperatures.			
Gm. Mols. Fe(CNS) <sub>3</sub> per Liter.		$\frac{c}{c'}$ .	t°.	Gm. Mols. Fe(CNS) <sub>3</sub> per Liter.		$\frac{c}{c'}$ .	t°.
H <sub>2</sub> O Layer (a).	Ether Layer (c').			H <sub>2</sub> O Layer (a).	Ether Layer (c').		
0.0202	0.0108	1.87	0	0.0089	0.0167	0.532	
0.0119	0.0034	3.51	10	0.0127	0.0128	0.995	
0.0066	0.00093	7.07	20	0.0165	0.0091	1.814	
0.0035	0.00025	13.95	30	0.0196	0.0059	3.303	
			35	0.0207	0.0048	4.32	

Results for the effect of  $\text{HNO}_3$  upon the distribution at 25° are also given.

**ITACONIC ACID  $\text{CH}_3\text{C}(\text{COOH})\text{CH}_2\text{COOH}$ .**

Data for the distribution of itaconic acid between water and ether at 25° are given by Chandler, 1908.

**KERATIN.**

100 gms.  $\text{H}_2\text{O}$  dissolve 8.71 gms. keratin at 20–25°.

(Dehn, 1917.)

100 gms. aq. 50% pyridine dissolve 16 gms. keratin at 20–25°.

"

Pyridine mixes with keratin in all proportions at 20–25°.

"

**KRITON Kr. SOLUBILITY IN WATER. (von Antropoff, 1909–10.)**

(Results in terms of coefficient of absorption as defined by Bunsen, see p. 227, and modified by Kuenen in respect to substituting mass for volume of water involved.)

t°.	Abs. Coef. (First Series).	Abs. Coef. (Second Series).
0	0.1249	0.1166
10	0.0965	0.0877
20	0.0788	0.0670
30	0.0762	0.0597
40	0.0740	0.0561
50	0.0823	0.0610

The cause of the differences between the first and second series of results was not ascertained by the author.



**LACTIC ACID** (2)  $\text{CH}_3\text{CHOHCOOH}$ .

## DISTRIBUTION BETWEEN WATER AND ETHER.

(Pinnow, 1915.)

Results at 15°.			Results at 27.5°.		
Gm. Mols. Acid per Liter:		$\frac{w}{e}$	Gm. Mols. Acid per Liter:		
H <sub>2</sub> O Layer (w).	Ether Layer (e).		H <sub>2</sub> O Layer (w).	Ether Layer (e).	
1.98	0.215	9.19	1.354	0.130	
1.351	0.133	10.15	0.3203	0.0278	
0.297	0.0246	12.08	0.1855	0.0156	
0.1448	0.0118	12.27			
0.0548	0.0046	11.88			

F.-pt. data for mixtures of trichlorolactic acid and dimethylpyrone are Kendall, 1914.

**LACTOSE** (see sugars, pages 695-7).

**LANTHANUM BROMATE**  $\text{La}(\text{BrO}_3)_3 \cdot 9\text{H}_2\text{O}$ .

100 gms. H<sub>2</sub>O dissolve 28.5 gms. lanthanum bromate at 15°.

**LANTHANUM CITRATE**  $2(\text{LaC}_3\text{H}_5\text{O}_7) \cdot 7\text{H}_2\text{O}$ .

100 gms. aq. citric solution containing 10 gms. citric acid per 100 cc. 0.8 gm.  $\text{La}(\text{C}_6\text{H}_5\text{O}_7)_3$  at 20°. (Holm)

**LANTHANUM CobaltiCYANIDE**  $\text{La}_2(\text{CoC}_6\text{N}_6)_3 \cdot 9\text{H}_2\text{O}$ .

100 gms. aq. 10% HCl ( $d_{15} = 1.05$ ) dissolve 10.41 gms. salt at 25°. (James and Wil)

**LANTHANUM GLYCOLATE**  $\text{La}(\text{C}_2\text{H}_3\text{O}_3)_3$ .

One liter H<sub>2</sub>O dissolves 3.328 gms.  $\text{La}(\text{C}_2\text{H}_3\text{O}_3)_3$  at 20°. (Jantsch and Grunkat)

**LANTHANUM IODATE**  $\text{La}(\text{IO}_3)_3$ .

SOLUBILITY IN WATER AND IN AQ. SALT SOLUTIONS AT 25°. (Harkins and Pearce, 1916.)

1000 gms. H<sub>2</sub>O dissolve 0.6842 gm.  $\text{La}(\text{IO}_3)_3$  at 25°,  $d_{25}^{\text{sat. sol.}} = 0.9$

Salt.	Conc. of Salt, Milli-Normal.	Gms. $\text{Li}(\text{IO}_3)_3$ per Liter.	$d_{25}^{\text{sat. sol.}}$	Salt.	Conc. of Salt, Milli-Normal.	Gms. $\text{Li}(\text{IO}_3)_3$ per Liter.
$\text{La}(\text{NO}_3)_3$	2	0.5595	0.99732	$\text{NaNO}_3$	25	0.86901
"	5	0.5288	0.99807	"	50	0.99040
"	10	0.5194	0.99859	"	100	1.1603
"	50	0.5522	1.00212	"	200	1.385
"	100	0.6214	1.00661	"	400	1.636
"	200.52	0.7431	1.01533	"	800	2.156
$\text{KIO}_3$	0.0990	0.6290	1.00030	"	1600	2.859
"	0.4957	0.5633	1.00027	"	3200	3.030
"	0.9914	0.4970	1.00030	$\text{La}(\text{NO}_3)_3 \cdot 2\text{NH}_4\text{NO}_3$	26.34	0.631
"	1.9828	0.3738	1.00031			
$\text{NaIO}_3$	0.0913	0.63538	1.00060	"	52.68	0.674
"	0.4560	0.56466	1.00059	"	105.36	0.754
"	0.9130	0.50835	1.00065	"	158.04	0.816
"	1.8260	0.39938	1.00065	"	196.83	0.867
"	3.6530	0.19736	1.00069	"	393.67	1.063
"	4.5326	0.13393	1.00083	"	787.35	1.364
"	6.7989	0.09733	1.00130	"	1574.70	1.923

According to Rimbach and Schubert (1909), one liter H<sub>2</sub>O dissolves 1.  $\text{Li}(\text{IO}_3)_3$  at 25°, determined chemically, and 1.871 gms. determined electro solid phase,  $2\text{La}(\text{IO}_3)_3 \cdot 3\text{H}_2\text{O}$ .

**LANTHANUM MALONATE**  $\text{La}_2(\text{C}_3\text{H}_3\text{O}_4)_3 \cdot 5\text{H}_2\text{O}$ .

100 gms. aq. Am. malonate sol. (10 gms. per 100 cc.) dissolve 0.2 gm.  $\text{La}_2$  (100 gms. aq. malonic acid sol. (20 gms. per 100 cc.) dissolve 0.6 gm.  $\text{La}_2$  at (Holm)



**LANTHANUM MOLYBDATE**  $\text{La}_2(\text{MoO}_4)_3$ .

Water dissolves 0.0179 gm.  $\text{La}_2(\text{MoO}_4)_3$  at 25° and 0.0332 gm. at 85°.  
(Hitchcock, 1895.)

**LANTHANUM Ammonium NITRATE**  $\text{La}(\text{NO}_3)_3 \cdot 2\text{NH}_4\text{NO}_3$ .

Water dissolves 181.4 gms.  $\text{La}(\text{NO}_3)_3 \cdot 2\text{NH}_4\text{NO}_3$  at 15°. (Holmberg, 1907.)

**LANTHANUM Double NITRATES.**

SOLUBILITY OF LANTHANUM DOUBLE NITRATES IN CONC.  $\text{HNO}_3$  ( $d_{15} = 1.325$ )  
AT 16°. (Jantsch, 1912.)

Salt.	Formula.	Gms. Hydrated Salt Dissolved per Liter Sat. Sol.
Lanthanum Magnesium Nitrate	$[\text{La}(\text{NO}_3)_6]_2\text{Mg}_3 \cdot 24\text{H}_2\text{O}$	63.8
Nickel "	" $\text{Ni}_3$ "	80.3
Cobalt "	" $\text{Co}_3$ "	109.2
Zinc "	" $\text{Zn}_3$ "	124.1
Manganese "	" $\text{Mn}_3$ "	193.1

**LANTHANUM NITRATE**  $\text{La}(\text{NO}_3)_3$ .

SOLUBILITY OF LANTHANUM NITRATE IN AQUEOUS SOLUTIONS OF LANTHANUM  
OXALATE AT 25° AND VICE VERSA. (James and Whittemore, 1912.)

Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
$\text{La}(\text{NO}_3)_3$		$\text{La}_2(\text{C}_2\text{O}_4)_3$	$\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 5\text{H}_2\text{O}$
60.17	$\text{La}(\text{NO}_3)_3$	not det.	not det.
59.91	"	3.32	$\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 8\text{H}_2\text{O}$
59.03	"	2.80	"
59.03	" + $\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 3\text{H}_2\text{O}$	2.51	"
58.22	$\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 3\text{H}_2\text{O}$	2.21	"
55.20	"	2.01	"
52.74	"	1.46	"
49.84	"	1.18	"
45.26	"	0.50	"
not det.	$\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 5\text{H}_2\text{O}$	0.28	5.06

**LANTHANUM OXALATE**  $\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 9\text{H}_2\text{O}$ .

Water dissolves 0.00062 gm.  $\text{La}_2(\text{C}_2\text{O}_4)_3$  at 25°, determined by electrolysis.  
(Rimbach and Schubert, 1909.)

1 aq. 10.2%  $\text{HNO}_3$  ( $d = 1.063$ ) dissolve 0.80 gm.  $\text{La}_2(\text{C}_2\text{O}_4)_3$  at 15°.

1 aq. 19.4%  $\text{HNO}_3$  ( $d = 1.116$ ) dissolve 2.69 gms.  $\text{La}_2(\text{C}_2\text{O}_4)_3$  at 15°.  
(v. Scheele, 1899.)

SOLUBILITY OF LANTHANUM OXALATE IN AQUEOUS SOLUTIONS OF SULFURIC  
ACID AT 25°. (Hauser and Wirth, 1908; Wirth, 1908; Wirth, 1912.)

Normality of H <sub>2</sub> SO <sub>4</sub> .	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
$\text{La}_2(\text{C}_2\text{O}_4)_3$		
0.0346	$\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 9\text{H}_2\text{O}$	2
0.1629	"	3.09
0.3962	"	4.32
0.5304	"	5.6

SOLUBILITY OF LANTHANUM OXALATE IN AQUEOUS SOLUTIONS OF OXALIC ACID  
AT 25°. (Hauser and Wirth, 1908.)

Normality of Oxalic Acid.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
$\text{La}_2(\text{C}_2\text{O}_4)_3$		
unweighable	$\text{La}_2(\text{C}_2\text{O}_4)_3$	$\text{La}_2(\text{C}_2\text{O}_4)_3 \cdot 9\text{H}_2\text{O}$
0.00032	0.00053	"
0.00045	0.00075	"

are also given for the solubility in mixtures of sulfuric and oxalic acids.  
1 aq. 20% triethylamineoxalate dissolve approx. 0.032 gm.  $\text{La}_2(\text{C}_2\text{O}_4)_3$ .  
(Grant and James, 1917.)



# LANTHANUM PHOSPHATE 348

**LANTHANUM Dimethyl PHOSPHATE**  $\text{La}_2[(\text{CH}_3)_2\text{PO}_3]_2 \cdot 4\text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 103.7 gms.  $\text{La}_2[(\text{CH}_3)_2\text{PO}_3]_2$  at  $25^\circ$ . (Morgan and James.)

**LANTHANUM SULFATE**  $\text{La}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$ .

SOLUBILITY IN WATER. (Muthmann and Röllig, 1896.)					
t°.	Gms. $\text{La}_2(\text{SO}_4)_3$ per 100 Gms.		t°.	Gms. $\text{La}_2(\text{SO}_4)_3$ per 100 Gms.	
	Solution.	Water.		Solution.	Water.
0	2.91	3	50	1.47	1.5
14	2.53	2.6	75	0.95	0.96
30	1.86	1.9	100	0.68	0.69

SOLUBILITY OF LANTHANUM SULFATE IN AQ. SOLUTIONS OF AMMONIUM SULFATE, POTASSIUM SULFATE AND SODIUM SULFATE. (Barre, 1910, 1911.)

In Aq. $(\text{NH}_4)_2\text{SO}_4$ at $18^\circ$ .			In Aq. $\text{K}_2\text{SO}_4$ at $16.5^\circ$ .			In Aq. $\text{Na}_2\text{SO}_4$ at $18^\circ$ .		
Gms. per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.		Gms. per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.		Gms. per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	
$(\text{NH}_4)_2\text{SO}_4$	$\text{La}_2(\text{SO}_4)_3$		$\text{K}_2\text{SO}_4$	$\text{La}_2(\text{SO}_4)_3$		$\text{Na}_2\text{SO}_4$	$\text{La}_2(\text{SO}_4)_3$	
4.01	0.393	1.1.2	0	2.198	1.0.9	0	2.130	1.4
8.73	0.279	"	0.247	0.727	1.1.2	0.395	0.997	1.
18.24	0.253	"	0.496	0.269	"	0.689	0.353	"
27.89	0.476*	"	0.846	0.185	"	0.774	0.299	"
36.11	0.277*	"	1.029	0.054	1.5	1.136	0.129	"
47.49	0.137	2.5	1.156	0.022	"	2.480	0.044	"
53.82	0.067	1.5				3.802	0.019	"
65.29	0.0117	"				5.548	0.016	"
73.78	0.0033	"						

\* = unstable equilibrium.

1.0.9 =  $\text{La}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$ , 1.1.2 =  $\text{La}_2(\text{SO}_4)_3 \cdot X_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$  (where  $X = (\text{N K or Na})$ ), 2.5 =  $2\text{La}_2(\text{SO}_4)_3 \cdot 5(\text{NH}_4)_2\text{SO}_4$ , 1.5 =  $\text{La}_2(\text{SO}_4)_3 \cdot 5X_2\text{SO}_4$ .

SOLUBILITY OF LANTHANUM SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT  $25^\circ$ . (Wirth, 1912.)

Normality of Aq. $\text{H}_2\text{SO}_4$ .	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Normality of Aq. $\text{H}_2\text{SO}_4$ .	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	$\text{La}_2\text{O}_3 = \text{La}_2(\text{SO}_4)_3$ .				$\text{La}_2\text{O}_3 = \text{La}_2(\text{SO}_4)_3$ .		
Water	1.43	2.483	$\text{La}_2(\text{SO}_4)_3 \cdot 9\text{H}_2\text{O}$	4.321	1.11	1.927	$\text{La}_2(\text{SO}_4)_3$
0.505	1.69	2.934	"	6.685	0.531	0.9217	"
1.10	1.796	3.118	"	9.68	0.266	0.4617	"
2.16	1.818	3.156	"	12.60	0.214	0.371	"
3.39	1.42	2.465	"	15.15	0.177	0.307	"

Data for the solubility of lanthanum sulfate in aq.  $\text{H}_2\text{SO}_4$  in presence of oxalic acid at  $25^\circ$  are given by Wirth, 1908.

## LANTHANUM SULFONATES.

SOLUBILITY OF EACH IN WATER.

Sulfonate.	Formula.	Gms. Anhydrous Sulfonate per 100 Gms. $\text{H}_2\text{O}$ .	Author.
Lanthanum Benzene Sulfonate	$\text{La}[\text{C}_6\text{H}_5\text{SO}_3]_3 \cdot 9\text{H}_2\text{O}$	63.1	(Holmberg,
" <i>m</i> Nitrobenzene Sulfonate	$\text{La}[\text{C}_6\text{H}_4\text{NO}_2\text{SO}_3]_3 \cdot 6\text{H}_2\text{O}$	16	"
" <i>m</i> Chlorobenzene Sulfonate	$\text{La}[\text{C}_6\text{H}_4\text{ClSO}_3]_3 \cdot 9\text{H}_2\text{O}$	13.1	"
" <i>m</i> Bromobenzene	$\text{La}[\text{C}_6\text{H}_4\text{BrSO}_3]_3 \cdot 9\text{H}_2\text{O}$	12.9	"
" (6) Chloro (3) Nitrobenzene (1) Sulfonate	$\text{La}[\text{C}_6\text{H}_3\text{Cl}(\text{NO}_2)\text{SO}_3]_3 \cdot 8\text{H}_2\text{O}$	24.5	"
" (1) Bromo (4) Nitrobenzene (2) Sulfonate	$\text{La}[\text{C}_6\text{H}_3\text{BrNO}_2\text{SO}_3]_3 \cdot 8\text{H}_2\text{O}$	5	(Katz & Jam
" $\alpha$ Naphthalene Sulfonate	$\text{La}[\text{C}_{10}\text{H}_7\text{SO}_3]_3 \cdot 6\text{H}_2\text{O}$	5.2	(Holmberg,
" 1.5 Nitronaphthalene Sulfonate	$\text{La}[\text{C}_{10}\text{H}_6(\text{NO})\text{SO}_3]_3 \cdot 6\text{H}_2\text{O}$	0.55	"
" 1.6	"	0.21	"
" 1.7	"	0.11	"



**LANTHANUM TARTRATE**  $\text{La}_2(\text{C}_4\text{H}_4\text{O}_6)_2 \cdot 9\text{H}_2\text{O}$ .

One liter  $\text{H}_2\text{O}$  dissolves 0.059 gm.  $\text{La}_2(\text{C}_4\text{O}_6)_3$  at  $25^\circ$  (solid phase  $\text{La}_2(\text{C}_4\text{H}_4\text{O}_6)_2 \cdot 3\text{H}_2\text{O}$ ). Determined by electrolytic method. (Rimbach and Schubert, 1909.)

**SOLUBILITY OF LANTHANUM TARTRATE IN AQ. TARTARIC ACID AND AMMONIUM TARTRATE SOLUTIONS AT  $20^\circ$ .**  
(Holmberg, 1907.)

In Aq. Tartaric Acid.		In Aq. Ammonium Tartrate.	
Gms. Tartaric Acid per 100 cc. Solvent.	Gms. $\text{La}_2(\text{C}_4\text{O}_6)_3$ per 100 Gms. Sat. Sol.	Gms. Am. Tartrate per 100 cc. Solvent.	Gms. $\text{La}_2(\text{C}_4\text{H}_4\text{O}_6)_2$ per 100 Gms. Sat. Sol.
20	0.6	10	0.2
40	1.2	20	0.6

**LANTHANUM TUNGSTATE**  $\text{La}_2(\text{WO}_4)_3$ .

One liter  $\text{H}_2\text{O}$  dissolves 0.0117 gm.  $\text{La}_2(\text{WO}_4)_3$  at  $27^\circ$  and 0.0236 at  $65^\circ$ . (Hitchcock, 1895.)

**LAURIC ACID**  $\text{C}_{12}\text{H}_{24}\text{COOH}$ .

**SOLUBILITY IN ALCOHOLS.**  
(Timofciew, 1894.)

Alcohol.	$t^\circ$ .	Gms. $\text{C}_{12}\text{H}_{24}\text{COOH}$ per 100 Gms. Sat. Sol.	Alcohol.	$t^\circ$ .	Gms. $\text{C}_{12}\text{H}_{24}\text{COOH}$ per 100 Gms. Sat. Sol.
Methyl Alcohol	0	14.8	Propyl Alcohol	0	21.5
"	21	58.6	"	21	52.6
Ethyl Alcohol	0	20.5	Isobutyl Alcohol	0	18.4
"	21	57.3	"	21	49.7

**LEAD** Pb.

An extensive investigation of the solubility of lead in the water passing through lead pipes is described by Paul, Ohlmüller, Heise and Auerbach, 1906. The solubility is increased by oxygen,  $\text{CO}_2$ , sulfates and perhaps other salts; it is decreased by hydrocarbonates.

**SOLUBILITY OF LEAD IN LIQUID AMMONIA-SODIUM SOLUTIONS AT  $-33^\circ$ .**  
(Smith, F. H., 1917.)

Gm. Atoms Sodium per Liter of Liquid Ammonia.	Gm. Atoms Pb Dissolved per Gm. Atom Na.	Gm. Atoms Na per Liter of Liquid Ammonia.	Gm. Atoms Pb Dissolved per Gm. Atom Na.
0.078	1.95	0.13	2.17
0.093	2.20	0.14	2.12
0.094	2.03	0.33	1.83
0.110	2.24	0.34	1.73
0.12	1.78		

**LEAD ACETATE**  $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 3\text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 55.04 gms.  $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2$  at  $25^\circ$ . (Jackson, 1914.)

**EQUILIBRIUM IN THE SYSTEM LEAD OXIDE, ACETIC ACID, WATER AT  $25^\circ$ .**  
(Sakabe, 1914.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
PbO.	$\text{CH}_3\text{COOH}$ .		PbO.	$\text{CH}_3\text{COOH}$ .	
4.18	21.53	$\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 3\text{H}_2\text{O}$	7.15	7.26	$(\text{C}_2\text{H}_3\text{O}_2)(\text{HO})\text{Pb} + (\text{C}_2\text{H}_3\text{O}_2)_2\text{Pb} \cdot 2(\text{HO})_2\text{Pb}$
3.80	16.78	"			
3.16	13.07	"	5.20	5.61	$(\text{C}_2\text{H}_3\text{O}_2)_2\text{Pb} \cdot 2(\text{HO})_2\text{Pb}$
2.64	5.49	"	3.78	4.17	"
3.34	5.36	"	2.89	2.51	"
4.38	7.30	"	1.45	1.03	"
5.18	7.92	" $+ (\text{C}_2\text{H}_3\text{O}_2)(\text{HO})\text{Pb}$	1.05	0.54	PbO
5.59	7.72	$(\text{C}_2\text{H}_3\text{O}_2)(\text{HO})\text{Pb}$	1.07	0.48	"
6.51	7.79	"	1	0.20	"

Equilibrium was attained quickly in the acid solutions but 2-3 days were required in case of the basic salts. Both sat. solutions and solid phases were analyzed.



EQUILIBRIUM IN THE SYSTEM LEAD ACETATE, LEAD OXIDE, WATER AT 25°  
(Jackson, 1914.)

$d_{25}$ of Sat. Sol.	Gms. per 100 PbO.	Gms. Sat. Sol. Pb(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> .	Solid Phase.	$d_{25}$ of Sat. Sol.	Gms. per 100 PbO.	Gms. Sat. Sol. Pb(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> .	Solid Phase.
1.326	-0.27*	35.19	1.3	2.280	24.74	49.21	3.1.3+1.2.4
1.334	+0.10	35.60	"	2.048	23.59	43.17	1.2.4
1.367	1.01	37.14	"	1.951	22.78	40.78	"
1.422	3.38	38.93	"	1.657	19.63	31.40	"
1.531	6.01	41.95	"	1.599	18.73	29.63	"
1.658	9.47	44.71	"	1.382	14.62	20.96	"
...	14.22	47.88	"	1.348	13.41	19.65	"
1.852	14.44	47.92	"	1.229	10.66	12.99	"
...	15.89	48.95	1.3+3.1.3	1.157	8.47	8.64	"
1.930	15.90	48.42	3.1.3	1.119	7.87	5.27	"
1.942	16.25	48.85	"	1.117	7.79	5.25	"
1.956	16.65	49.04	"	...	7.17	4.17	Pb(OH) <sub>2</sub>
2.024	18.83	48.71	"	1.100	6.84	4.31	"
2.161	22.23	48.52	"	1.095	6.54	4.25	"
2.193	22.94	48.96	"	1.085	5.91	3.82	"
...	23.28	49.14	"	1.075	5.29	3.40	"
2.220	23.53	49.01	"	...	0.20	0.11	"

\* In this case the acidity is expressed in terms of PbO.

1.3 = Pb(C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub>·3H<sub>2</sub>O, 3.1.3 = 3Pb(C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub>·PbO·3H<sub>2</sub>O, 1.2.4 = Pb(C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub>·2PbO·4H<sub>2</sub>O.

The above results show the solubility of lead acetate in aqueous solutions containing increasing amounts of lead hydroxide. The mixtures were constantly agitated for periods varying from 2 to 7 days. Both the saturated solutions and the solid phases were analyzed. The basic lead in a given sample was determined by measuring the volume of standard acid neutralized by it. The neutral lead acetate was determined by precipitation of the lead as sulfate or as oxalate.

SOLUBILITY OF LEAD ACETATE IN AQ. SOLUTIONS OF POTASSIUM ACETATE AT 25°  
(Fox, 1909.)

Gms. per 100 CH <sub>3</sub> COOK.	Gms. Sat. Sol. (CH <sub>3</sub> COO) <sub>2</sub> Pb.	Solid Phase.
0	35.9	(CH <sub>3</sub> COO) <sub>2</sub> Pb·3H <sub>2</sub> O
13.87	38.05	"
15.40	36.90	"

SOLUBILITY OF LEAD ACETATE IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°  
(Seidell, 1910.)

Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	$d_{25}$ of Sat. Sol.	Gms. (C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> Pb per 100 Gms. Sat. Sol.	Solid Phase.	Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	$d_{25}$ of Sat. Sol.	Gms. (C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> Pb per 100 Gms. Sat. Sol.	Solid Phase.
0	1.343	36.5	(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> Pb·3H <sub>2</sub> O	70	0.955	12.4	(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> Pb·3H <sub>2</sub> O
10	1.275	32.3	"	80	0.907	9.4	"
20	1.215	28.6	"	81	0.905	9	"
30	1.157	25	"	85	0.855	4	(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> Pb
40	1.105	21.9	"	90	0.826	1.6	"
50	1.055	18.7	"	95	0.806	0.6	"
60	1.002	15.6	"	100	0.790	0.4	"

100 gms. 95% formic acid dissolve 0.99(?) gm. Pb(C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub> at 19.8°. (Aschan, 1913.)100 gms. anhydrous lanolin (m. pt. 46°) dissolve 1.1 gm. Pb(C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub> at 45°. (Klose, '07.)100 gms. glycerol dissolve about 20 gms. Pb(C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub> at 15°. (Ossendowski, 1907.)LEAD ARSENATE PbHAsO<sub>4</sub>.

Two gm. portions of amorphous dilead arsenate were agitated at 32° with 90 to 180 cc. portions of 0.0338 normal aqueous ammonia for two days. The saturated solutions were found to contain only traces of lead but amounts of As<sub>2</sub>O<sub>3</sub> varying from 1.956 to 1.429 gms. per liter.

(McDonnell and Smith, 1916.)



**LEAD BENZOATE**  $\text{Pb}(\text{C}_7\text{H}_5\text{O}_2)_2 \cdot \text{H}_2\text{O}$ .SOLUBILITY IN WATER.  
(Pajetta, 1906.)

$t^\circ$ .	$18^\circ$ .	$40.6^\circ$ .	$49^\circ$ .
Gms. $\text{Pb}(\text{C}_7\text{H}_5\text{O}_2)_2$ per 100 gms. sat. sol.	0.149	0.249	0.310

**LEAD BORATE**  $\text{Pb}(\text{BO}_3)_2 \cdot \text{H}_2\text{O}$ .

100 cc. anhydrous hydrazine dissolve about 2 gms.  $\text{Pb}(\text{BO}_3)_2$  at room temp.  
(Welsh and Brodersen, 1915.)

**LEAD BROMATE**  $\text{Pb}(\text{BrO}_3)_2 \cdot \text{H}_2\text{O}$ .

100 gms. water dissolve 1.32 gms.  $\text{Pb}(\text{BrO}_3)_2$  at  $19.94^\circ$ .  
(Rammelsberg, 1841; Böttger, 1903.)

**LEAD BROMIDE**  $\text{PbBr}_2$ .

## SOLUBILITY IN WATER.

(Lichty — J. Am. Chem. Soc. 25, 474, '03.)

$t^\circ$ .	Density of Solutions, $\text{H}_2\text{O}$ at $0^\circ$ .	Gms. $\text{PbBr}_2$ per 100		Milligram Mols. $\text{PbBr}_2$ per 100	
		cc. Solution.	Gms. $\text{H}_2\text{O}$ .	cc. Solution.	Gms. $\text{H}_2\text{O}$ .
0	1.0043	0.4554	0.4554	1.242	1.242
15	1.0053	0.7285	0.7305	1.987	1.989
25	1.0061	0.9701	0.9744	2.646	2.655
35	1.0060	1.3124	1.3220	3.577	3.603
45	1.0059	1.7259	1.7457	4.705	4.760
55	1.0046	2.1024	2.1376	5.731	5.827
65	1.0028	2.516	2.574	6.859	7.016
80	1.0000	3.235	3.343	8.819	9.113
95	0.9995	4.1767	4.3613	11.386	11.890
100	...	4.550	4.751	12.40	12.94

SOLUBILITY OF LEAD BROMIDE IN AQUEOUS HYDROBROMIC ACID  
AT  $10^\circ$ .

100 grams  $\text{H}_2\text{O}$  containing 72.0 grams  $\text{HBr}$  dissolve 55.0 grams  $\text{PbBr}_2$  per 100 gms. solvent, and solution has Sp. Gr. 2.06.

(Ditte — Compt. rend 92, 719, '81.)

## SOLUBILITY OF LEAD BROMIDE IN PYRIDINE.

(Heise, 1912.)

$t^\circ$ .	Gms. $\text{PbBr}_2$ per 100 Gms. Pyridine.	Solid Phase.	$t^\circ$ .	Gms. $\text{PbBr}_2$ per 100 Gms. Pyridine.	Solid Phase.
-26	1.02	$\text{PbBr}_{1.3}\text{C}_5\text{H}_5\text{N}$	45	0.661	$\text{PbBr}_{1.2}\text{C}_5\text{H}_5\text{N}$
-10	0.89	"	64	0.800	"
-5	0.84	"	77	0.969	"
0	0.80	"	95	1.33	"
+13	0.661	"	100	1.44	"
19 tr. pt.	...	" + $\text{PbBr}_{1.2}\text{C}_5\text{H}_5\text{N}$	105	1.56	"
26	0.583	$\text{PbBr}_{1.2}\text{C}_5\text{H}_5\text{N}$			

FREEZING-POINT DATA (Solubility, see footnote, p. 1) ARE GIVEN FOR THE  
FOLLOWING MIXTURES OF LEAD BROMIDE AND OTHER COMPOUNDS.

Lead Bromide + Lead Chloride	(Mönkemeyer, 1906.)
" " + Lead Iodide	"
" " + Lead Fluoride	(Sandonnini, 1911.)
" " + Lead Oxide	(Sandonnini, 1914.)
" " + Mercuric Bromide	(Sandonnini, 1912, 1914.)
" " + Silver Bromide	(Matthes, 1911.)



**LEAD BROMIDE**

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**LEAD Dicyclohexyl DiBROMIDE**  $(C_6H_{11})_2PbBr_2$ .**LEAD Dicyclohexyl DiCHLORIDE**  $(C_6H_{11})_2PbCl_2$ .

SOLUBILITY OF EACH IN SEVERAL SOLVENTS AT 22.5°.

(Grüttner, 1914.)

Solvent.	Grams per 100 Grams Solvent.	
	$(C_6H_{11})_2PbBr_2$ .	$(C_6H_{11})_2PbCl_2$ .
Benzene	0.014	0.016
Carbon Tetrachloride	0.004	0.004
Chloroform	0.078	0.083
Alcohol + Pyridine (1:1)	2.560	2.904

Similar results are also given for lead tetracyclohexyl,  $Pb(C_6H_{11})_4$ , lead tetraphenyl,  $Pb(C_6H_5)_4$ , and lead diphenyldicyclohexyl,  $Pb(C_6H_5)_2(C_6H_{11})_2$ .

Solvent.	Gms. per 100 Gms. Solvent.		
	$Pb(C_6H_{11})_4$ .	$Pb(C_6H_5)_4$ .	$Pb(C_6H_5)_2(C_6H_{11})_2$ .
Alcohol	0.010	0.020	0.324
Benzene	1.068	1.145	2.298
Carbon Tetrachloride	0.244	0.303	0.845
Ethyl Acetate	0.030	0.123	0.231

**LEAD CAPROATE, CAPRYLATE, CAPRATE, etc.**

SOLUBILITY OF EACH IN ETHER AND IN PETROLEUM ETHER.

(Neave, 1912.)

Lead Salt.	Melting point.	Solubility in Ethyl Ether.		Solubility in Pet. Ether.	
		Gms. Salt per 100 cc. Sat. Sol.		Gms. Salt per 100 cc. Sat. Sol.	
		At 20°.	At B. pt. of Sat. Sol.	At 20°.	At B. pt. of Sat. Sol.
Pb Caproate	73-74	...	1.364	...	0.0608
" Heptylate	90.5-91.5	0.2397	1.490	0.020	0.0528
" Caprylate	83.5-84.5	0.0938	0.546	practically insol.	0.0384
" Nonylate	94-95	0.1115	0.2404	"	0.0450
" Caprate	100	0.0290	0.4285	"	0.0170
" Myristate	107	practically insol.	0.0555	"	0.0210
" Laurate	103-104	"	0.0205	"	practically insol.
" Palmitate	112	"	0.0261	"	"
" Stearate	125	"	practically insol.	"	0.0170

The ethyl ether was distilled over sodium. Petroleum ether distilling between 40°-60° was used. The solutions were stirred constantly at 20°. A definite volume of the sat. solution was evaporated to dryness and residue weighed in each case.

**LEAD CARBONATE**  $PbCO_3$ .

SOLUBILITY IN WATER BY ELECTRICAL CONDUCTIVITY METHOD.

(Kohlrausch and Rose, 1893; Böttger, 1903.)

1 liter of water dissolves 0.0011-0.0017 gm.  $PbCO_3$  at 20°.

SOLUBILITY OF LEAD CARBONATE (NEUTRAL) IN AQUEOUS SOLUTIONS OF CARBON DIOXIDE AT 18°.

(Pleissner, 1907.)

Millimols per Liter.		Milligrams per Liter.	
$CO_2$ .	$PbCO_3$ .	$CO_2$ .	$PbCO_3$ .
0	0.008	0	1.75
0.064	0.029	2.8	6
0.123	0.034	5.4	7
0.328	0.040	14.4	8.2
0.592	0.048	26	9.9
0.988	0.053	43.5	10.9
2.40	0.076	106	15.4

A determination of the solubility of basic lead carbonate in water gave 1.61  $Pb_3(CO_3)_2(OH)_2$  per liter = 1.3 mg. Pb or 0.006 millimol Pb.



Data for equilibrium in the system composed of  $K_2CO_3 + PbCO_3 + K_2CrO_4 + PbCrO_4$  at 25° are given by Goldblum and Stoffella, 1910.

Data for equilibrium by lead carbonate precipitation in aq. solutions of sodium salts at 25° are given by Herz, 1911.

#### LEAD CHLORATE $Pb(ClO_3)_2 \cdot H_2O$ .

100 grams  $H_2O$  dissolve 151.3 gms.  $Pb(ClO_3)_2$ , or 100 gms. sat. solution contains 60.2 gms.  $Pb(ClO_3)_2$  at 18°. Density of solution, 1.947. (Mylus and Funk, 1897.)  
100 gms.  $H_2O$  dissolve 440 gms.  $Pb(ClO_3)_2$  at 18°,  $d_{18} = 1.63$ . (Carlson, 1910.)

#### LEAD CHLORIDE $PbCl_2$ .

SOLUBILITY IN WATER. (Lichty; see also Formanek, 1887; Bell, 1867; Ditte, 1881.)

t°.	Density of Solutions, $H_2O$ at 0°.	Gms. $PbCl_2$ per 100		Milligram Mols. $PbCl_2$ per 100	
		cc. Solution.	Gms. $H_2O$ .	cc. Solution.	Grams $H_2O$ .
0	1.0066	0.6728	0.6728	2.421	2.421
15	1.0069	0.9070	0.9090	3.265	3.272
25	1.0072	1.0786	1.0842	3.882	3.903
35	1.0060	1.3150	1.3244	4.733	4.767
45	1.0042	1.5498	1.5673	5.579	5.644
55	1.0020	1.8019	1.8263	6.486	6.573
65	0.9993	2.0810	2.1265	7.490	7.651
80	0.9947	2.5420	2.6224	9.150	9.439
95	0.9894	3.0358	3.1654	10.926	11.394
100	...	3.208	3.342	11.52	12.01

#### SOLUBILITY OF LEAD CHLORIDE IN AQUEOUS SOLUTIONS OF ACETIC ACID AT 25°. (Hill, 1917.)

Normality of Acetic Acid.	Dissolved $PbCl_2$ .		Normality of Acetic Acid.	Dissolved $PbCl_2$ .	
	Gms. per Liter.	Equiv. per Liter.		Gms. per Liter.	Equiv. per Liter.
0	10.77	0.07753	0.465	10.27	0.07392
0.05	10.82	0.07782	0.929	9.45	0.06803
0.10	10.85	0.07717	1.845	7.90	0.05686
0.20	10.70	0.07703	3.680	5.26	0.04788

#### SOLUBILITY OF LEAD CHLORIDE IN AQUEOUS AMMONIUM CHLORIDE AT 22°. (Brönsted, 1911.)

Gm. Equivalents per Liter.		Solid Phase.	Gm. Equivalents per Liter.		Solid Phase.
$NH_4Cl$	$PbCl_2$		$NH_4Cl$	$PbCl_2$	
0	0.0749	$PbCl_2$	0.8	0.0087	$NH_4Cl \cdot 2PbCl_2$
0.1	0.0325	"	1	0.0080	"
0.2	0.0194	"	1.5	0.0073	"
0.4	0.0138	"	2.5	0.0092	"
0.5	0.0130	"	4	0.0182	"
0.52	0.0127	" + $NH_4Cl \cdot 2PbCl_2$	6	0.0473	"
0.55	0.0123	$NH_4Cl \cdot 2PbCl_2$	7.20	0.0898	" + $NH_4Cl$
0.65	0.0105	"	7.20	0	$NH_4Cl$

For additional results at 25.2° see von Ende, 1901.

#### SOLUBILITY OF LEAD CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID.

Results at 18°. (Pleissner, 1907.)

Normality of HCl.	Gms. $PbCl_2$ per Liter.
0	9.34
0.0001	9.305
0.0002	9.300
0.0005	9.243
0.00102	9.200
0.0102	8.504

Results at 25.2°. (von Ende, 1901.)

Normality of HCl.	Millimols $PbCl_2$ per Liter.	Normality of HCl.	Millimols $PbCl_2$ per Liter.
0	38.8	1.026	4.41
0.0045	37.35	2.051	5.18
0.0151	33.75	3.085	7.78
0.0452	25.46	5	10.38
0.1850	10.25	7.5	65.86
0.5142	5.37	12.05	164.30



[illegible]



**SOLUBILITY OF LEAD CHLORIDE IN AQUEOUS SOLUTIONS OF LEAD NITRATE AT 25°.**  
**Results by Harkins, 1911.**

Gms. per Liter Sat. Sol.	PbCl <sub>2</sub>	d <sub>4</sub> <sup>20</sup> of Sat. Sol.	Aq. Pb(NO <sub>3</sub> ) <sub>2</sub> Sol., Gms. per 1000 Gms. H <sub>2</sub> O.	Gms. PbCl <sub>2</sub> per 1000 Gms. Sat. Sol.
Pb(NO <sub>3</sub> ) <sub>2</sub>				
0	10.81	1.0069	0	10.89
3.31	10.67	1.0095	3.31	10.96
8.28	10.65	1.0139	6.62	10.53
16.56	10.84	1.0210	33.12	11.15
33.12	11.57	...	82.80	12.95

**Results by Armstrong and Eyre, 1913.**

**SOLUBILITY OF LEAD CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE AT 25.2°.** (von Ende, 1901.)

Normality of KCl.	Gm. Equiv. PbCl <sub>2</sub> per Liter.	Normality of KCl.	Gm. Equiv. PbCl <sub>2</sub> per Liter.
0	0.07760	0.0999	0.02380
0.001	0.07664	0.5006	0.01480
0.0025	0.07570	0.7018	0.01476
0.0049	0.07404	0.9991	0.00980
0.0099	0.07056	1.5018	0.00996
0.0200	0.06432	2.0024	0.01112
0.0599	0.04524	3.0036	0.01948

**SOLUBILITY OF LEAD CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE AT 20°.** (Brønsted, 1912.)

Gm. Equivalents per 1000 Gms. Solution.	KCl.	PbCl <sub>2</sub> .	Solid Phase.	Gm. Equivalents per 1000 Gms. Solution.	KCl.	PbCl <sub>2</sub> .	Solid Phase.
0.195	0.01900	PbCl <sub>2</sub>		2.10	0.01022	2PbCl <sub>2</sub> .KCl	
0.299	0.01452	"		2.20	0.01060	"	
0.375	0.01324	"		2.29	0.01184	"	
0.483	0.01236	"		2.36	0.01300	2PbCl <sub>2</sub> .KCl + PbCl <sub>2</sub> .KCl.H <sub>2</sub> O	
0.510	0.0125	" + 2PbCl <sub>2</sub> .KCl		2.45	0.01308	PbCl <sub>2</sub> .KCl.H <sub>2</sub> O	
0.575	0.01068	2PbCl <sub>2</sub> .KCl		2.66	0.01396	"	
0.639	0.00954	"		2.77	0.01476	"	
0.930	0.00770	"		2.91	0.01550	"	
1.224	0.00736	"		3.05	0.01656	"	
1.575	0.00786	"		3.18	0.01780	"	
1.884	0.00894	"		4.57*	0.0280*	" + KCl	

\* = Gm. equivalents per 1000 Gms. H<sub>2</sub>O.

Data for the solubility of lead chloride in aqueous KCl and aqueous NaCl are given by Demassieux, 1914.

**SOLUBILITY OF LEAD CHLORIDE IN AQUEOUS SOLUTIONS OF ALCOHOL AND OF MANNITOL AT 25°.** (Kernot and Pomilio, 1912.)

**Results for Aqueous Ethyl Alcohol.** **Results for Aqueous Mannitol.**

Gms. per Liter Solution.	C <sub>2</sub> H <sub>5</sub> OH.	PbCl <sub>2</sub> .	Gms. per Liter Solution.	(CH <sub>2</sub> OH) <sub>2</sub> (CHOH) <sub>4</sub> .	PbCl <sub>2</sub> .
0	10.75		0	10.75	
5.75	10.16		2.84	10.42	
11.51	9.36		5.69	10.67	
23.02	9.14		11.38	10.64	
46.05	8.25		22.76	10.91	
92.10	7.12		45.53	11.16	
184.20	4.76		91.06	11.29	

**SOLUBILITY OF LEAD CHLORIDE IN GLYCEROL.** (Prease, 1874.)

1 part glycerol + 7 parts H<sub>2</sub>O dissolve 0.91 per cent PbCl<sub>2</sub>.  
 1 part glycerol + 3 parts H<sub>2</sub>O dissolve 1.04 per cent PbCl<sub>2</sub>.  
 1 part glycerol + 1 part H<sub>2</sub>O dissolves 1.32 per cent PbCl<sub>2</sub>.  
 Pure glycerol dissolves 2 per cent PbCl<sub>2</sub>.



## SOLUBILITY OF LEAD CHLORIDE IN AQUEOUS SOLUTIONS OF SEVEN COMPOUNDS AT 25°. (Armstrong and Eyre, 1913.)

Aqueous Solution of:	Gms. Cmpd. per 1000 Gms. H <sub>2</sub> O.	Gms. PbCl <sub>2</sub> per 1000 Gms. Sat. Sol.	Aqueous Solution of:	Gms. Cmpd. per 1000 Gms. H <sub>2</sub> O.	G
Water alone	0	10.89	Ethyl Alcohol	11.51	
Glycol	15.51	10.75	Glycerol	23.01	
"	62.04	10.90	Propyl Alcohol	15.01	
Acetaldehyde	11.01	10.54	"	60.06	
"	33.03	9.82	Methyl Acetanilide	29.82	
Paraldehyde	11.01	10.50	Hydrochloric Acid	9.12	
"	33.02	9.96	"	18.23	

100 cc. anhydrous hydrazine dissolve 3 gms. PbCl<sub>2</sub> at ord. temp. with position. (Welsh and Broden)

## SOLUBILITY OF LEAD CHLORIDE IN PYRIDINE. (Heise, 1912.)

t°.	Gms. PbCl <sub>2</sub> per 100 Gms. Pyridine.	Solid Phase.	t°.	Gms. PbCl <sub>2</sub> per 100 Gms. Pyridine.	Solid F
-20	0.303	PbCl <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N	76	0.893	PbCl <sub>2</sub> ·2
0	0.364	"	90	1.07	"
+22	0.459	"	94	1.12	"
44	0.559	"	102	1.31	"
65	0.758	"			

FREEZING-POINT DATA (Solubility, see footnote, p. 1) ARE GIVEN THE FOLLOWING MIXTURES OF LEAD CHLORIDE AND OTHER COMPOUNDS.

Lead Chloride	+ Lead Fluoride	(Sandonnini, 1911.)
"	+ Lead Iodide	(Monkemeyer, 1906.)
"	+ Lead Oxide	(Ruer, 1906.)
"	+ Lead Sulfide	(Truthe, 1912.)
"	+ Lithium Chloride	(Tries, 1914.)
"	+ Magnesium Chloride	(Menge, 1911.)
"	+ Manganese Chloride	(Sandonnini, 1911, 1914.)
"	+ Potassium Chloride	(Tries, 1914; Lorenz and Ruckstuhl,
"	+ Rubidium Chloride	"
"	+ Silver Chloride	(Matthes, 1911; Tries, 1914.)
"	+ Strontium Chloride	(Sandonnini, 1911, 1914.)
"	+ Sodium Chloride	(Tries, 1914.)
"	+ Thallium Chloride	(Korring, 1914; Sandonnini, 1913.)
"	+ Tin Chloride	(Hermann, 1911; Sandonnini, 1911, 1
"	+ Zinc Chloride	(Herrmann, 1911.)

## LEAD CHLORIDE (Basic).

SOLUBILITY OF BASIC LEAD CHLORIDES IN WATER AT 18°. (Pleissner)

Compound	Formula.	Gms. per Liter Sat Solution.
$\frac{1}{2}$ Basic Lead Chloride	PbCl <sub>2</sub> ·PbO·H <sub>2</sub> O	0.079
$\frac{3}{4}$ " " "	PbCl <sub>2</sub> ·3PbO·H <sub>2</sub> O	0.021

## LEAD FluoroCHLORIDE PbFCl.

SOLUBILITY OF LEAD FLUOROCHLORIDE IN WATER AND IN AQUEOUS SOLUTIONS (Stark, 1911.)

Solubility in Water.			Solubility in Aq. Solutions at 2		
t°.	Gms. PbFCl per 100 Gms. H <sub>2</sub> O.	Aq. Solution of:	Gms. PbFCl per 100 cc. Sat. Sol.	Aq. Solution of:	G
0	0.0211	0.00996 n PbCl <sub>2</sub>	0.0030	0.0535 n HCl	
18	0.0325	0.0195 n "	0.0008	0.1069 n "	
25	0.0370	0.0392 n "	0.0005	0.0518 n CH <sub>3</sub> COOH	
100	0.1081			0.1055 n "	



**LEAD CHROMATE  $\text{PbCrO}_4$** **SOLUBILITY OF LEAD CHROMATE IN WATER.**

<i>t</i> .	Mols. $\text{PbCrO}_4$ per Liter.	Gms. $\text{PbCrO}_4$ per Liter.	Method.	Authority.
18	$3.0 \cdot 10^{-7}$	0.00010	Solution equilibrium	(Beck and Stegmüller, 1910.)
..	$1.4 \cdot 10^{-7}$	0.00004	"	(Auerbach and Pick.)
18	$3.2 \cdot 10^{-7}$	0.00010	Conductivity	(Kohlrausch, 1908.)
20	$2.1 \cdot 10^{-7}$	0.00007	Radio Indicators	(v. Hevesy and Rona, 1915.)

**SOLUBILITY OF LEAD CHROMATE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC AND OF NITRIC ACIDS. (Beck and Stegmüller, 1910, 1911.)**

Normality of HCl.	Solubility in Aq. HCl. Milligrams Pb per 100 cc. Sat. Sol. at:			Solubility in Aq. $\text{HNO}_3$ at 18°.	
	18°.	25°.	37°.	Normality of $\text{HNO}_3$ .	Milligrams Pb per 100 cc. Sat. Sol.
0.1	3.86	4.96	7.40	0.1	2.67
0.2	8.15	10.06	15.40	0.2	4.70
0.3	13.56	17.38	27.30	0.3	6.46
0.4	22.14	27.78	43.60	0.4	8.31
0.5	32.30	42.60	68	0.5	10.31
0.6	46.60	61.06	97.20	0.6	12.39

Results are also given for the solubility of mixtures of lead chromate and lead sulfate in aqueous hydrochloric acid at 25° and 37°.

**SOLUBILITY OF LEAD CHROMATE IN AQUEOUS POTASSIUM HYDROXIDE SOLUTIONS. (Lacland and Lepierre, 1891.)**

<i>t</i> °.	Grams KOH per 100 cc.	Grams $\text{PbCrO}_4$ per 100 cc.
15	2.308	1.19
60	2.308	1.62
80	2.308	2.61
102	2.308	3.85

**LEAD CITRATE  $\text{Pb}(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot \text{H}_2\text{O}$** **SOLUBILITY IN WATER AND IN ALCOHOL.**

100 gms.  $\text{H}_2\text{O}$  dissolve 0.04201 gm.  $\text{Pb}(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot \text{H}_2\text{O}$  at 18°, and 0.05344 gm. at 25°.

100 gms. alcohol (95%) dissolve 0.0156 gm.  $\text{Pb}(\text{C}_6\text{H}_5\text{O}_7)_2 \cdot \text{H}_2\text{O}$  at 18°, and 0.0167 gm. at 25°. (Partheil and Hübner — Archiv. Pharm. 241, 413, '03.)

**LEAD DOUBLE CYANIDES.****SOLUBILITY IN WATER.**

(Schuler — Sitzber. Akad. Wiss. Wien, 79, 302, '79.)

Double Salt.	Formula.	<i>t</i> °.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .
Lead Cobalticyanide	$\text{Pb}_2[\text{Co}(\text{CN})_6]_2 \cdot 7\text{H}_2\text{O}$	18	56.5
Lead Cobalticyanide	$\text{Pb}_2[\text{Co}(\text{CN})_6]_2 \cdot 7\text{H}_2\text{O}$	19	61.3
Lead Potassium Cobalticyanide	$\text{PbKCo}(\text{CN})_6 \cdot 3\text{H}_2\text{O}$	18	14.8
Lead Cobalticyanide Nitrate	$\text{Pb}_2[\text{Co}(\text{CN})_6]_2 \cdot \text{Pb}(\text{NO}_3)_2 \cdot 12\text{H}_2\text{O}$	18	5.9
Lead Ferricyanide Nitrate	$\text{Pb}_2[\text{Fe}(\text{CN})_6]_2 \cdot \text{Pb}(\text{NO}_3)_2 \cdot 12\text{H}_2\text{O}$	16	7.5
Lead Potassium Ferricyanide	$\text{PbKFe}(\text{CN})_6 \cdot 3\text{H}_2\text{O}$	16	21.0

**LEAD FLUORIDE  $\text{PbF}_2$** 

One liter of water dissolves 0.6 gm.  $\text{PbF}_2$  at 9°, 0.64 gm. at 18°, and 0.68 gm. at 26° (conductivity method). (Kohlrausch, 1908.)

100 cc anhydrous hydrazine dissolve 6 gms.  $\text{PbF}_2$  at room temp. with decomposition. (Welsh and Broderson, 1915.)

Freezing-point data (solubility, see footnote, see p. 1) for mixtures of  $\text{PbF}_2$  and  $\text{PbI}_2$  are given by Sandonnini (1911); for mixtures of  $\text{PbF}_2$  +  $\text{PbO}$  by Sandonnini (1914); for mixtures of  $\text{PbF}_2$  +  $\text{Pb}_3(\text{PO}_4)_2$  by Amadari (1912), and for  $\text{PbF}_2$  +  $\text{NaF}$  by Puchin and Baskow (1913).



## LEAD FORMATE

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### LEAD FORMATE $\text{Pb}(\text{HCOO})_2$ .

SOLUBILITY OF LEAD FORMATE IN AQUEOUS SOLUTIONS OF BARIUM FORMATE:  
(Fock, 1897.)

Mol. % in Solution.		Grams per Liter.		Sp. Gr. of Solutions.	In Solid Phase Mol. %	
$\text{Pb}(\text{HCOO})_2$ .	$\text{Ba}(\text{HCOO})_2$ .	$\text{Pb}(\text{HCOO})_2$ .	$\text{Ba}(\text{HCOO})_2$ .		$\text{Pb}(\text{HCOO})_2$ .	$\text{Ba}(\text{HCOO})_2$ .
0	100	...	28.54	1.2204	0	100
0.29	99.71	1.104	28.65	1.2213	1.72	98.2
0.74	99.26	2.803	28.90	1.2251	5.29	94.7
1.24	98.76	5.309	32.24	1.2529	11.94	88.0
2.91	97.09	11.42	29.29	1.2341	24.81	75.2
5.92	94.08	23.11	28.13	1.2355	56.54	43.4
100	0	28.35	...	1.0911	100	0

### LEAD HYDROXIDE $\text{Pb}(\text{OH})_2$ .

SOLUBILITY OF LEAD HYDROXIDE IN AQUEOUS SOLUTIONS OF SODIUM HYDROXIDE  
(Moist Lead Hydroxide used, temperature not given.)  
(Rubenbauer, 1902.)

Amount of Na in 20 cc.	Amt. of Pb in 20 cc.	Mol. Dilution of NaOH.	Grams per 100 cc. Solution.	
			NaOH.	$\text{Pb}(\text{OH})_2$ .
0.2024	0.1012	2.27	1.759	0.590
0.3196	0.1736	1.44	2.778	1.010
0.5866	0.3532	0.785	5.10	2.056
0.9476	0.4071	0.485	8.235	2.370
1.7802	0.5170	0.258	15.470	3.010

### LEAD IODATE $\text{Pb}(\text{IO}_3)_2$ .

One liter of water dissolves 0.0134 gm.  $\text{Pb}(\text{IO}_3)_2$  at 9.2°, 0.019 gm. at 11°  
0.023 gm. at 25.8° (Kohlrausch, 1908; Böttger)  
One liter  $\text{H}_2\text{O}$  dissolves 0.0307 gm.  $\text{Pb}(\text{IO}_3)_2$  at 25°. (Harkins and Winninghof)

SOLUBILITY OF LEAD IODATE IN AQUEOUS SALT SOLUTIONS AT 25°  
(H. and W., 1911)

Gms. per Liter.		Gms. per Liter.		Gms. per Liter.	
$\text{KNO}_3$ .	$\text{Pb}(\text{IO}_3)_2$ .	$\text{KIO}_3$ .	$\text{Pb}(\text{IO}_3)_2$ .	$\text{Pb}(\text{NO}_3)_2$ .	$\text{Pb}(\text{IO}_3)_2$ .
0.202	0.0318	0.0113	0.0199	1.656	0.0
1.011	0.0363	0.0227	0.0122	16.561	0.0
5.055	0.0567	$\text{Pb}(\text{NO}_3)_2$ .		82.805	0.0
20.220	0.0708	0.0165	0.0242	496.83	0.0
		0.165	0.0115		

### LEAD IODIDE $\text{PbI}_2$ .

SOLUBILITY IN WATER.  
(Lichty, 1903.)

t°.	Density. ( $\text{H}_2\text{O}$ at 0°.)	Grams $\text{PbI}_2$ per 100.		Millimols $\text{PbI}_2$ per 1	
		cc. Solution.	Grams $\text{H}_2\text{O}$ .	cc. Solution.	Grams
0	1.0006	0.0442	0.0442	0.096	0.0
15	0.9998	0.0613	0.0613	0.133	0.1
25	0.9980	0.0762	0.0764	0.165	0.1
35	0.9951	0.1035	0.1042	0.224	0.2
45	0.9915	0.1440	0.1453	0.312	0.3
55	0.9872	0.1726	0.1755	0.374	0.3
65	0.9827	0.2140	0.2183	0.464	0.4
80	0.9745	0.2937	0.3023	0.637	0.6
95	0.9671	0.3814	0.3960	0.828	0.8
100	...	0.420	0.436	0.895	0.9

Data for the solubility of lead iodide in water by the conductivity method given by Böttger, 1903; Kohlrausch, 1904-05; Denham, 1917.



**SOLUBILITY OF MIXTURES OF LEAD IODIDE AND POTASSIUM IODIDE IN WATER.**  
(Ditte, 1881; Schreinemakers, 1892.)

Gms. per 1000 Gms. H <sub>2</sub> O.		Solid Phase.	t°.	Gms. per 1000 Gms. H <sub>2</sub> O.		Solid Phase
PbI <sub>2</sub> .	KI.			PbI <sub>2</sub> .	KI.	
...	163	Double Salt + PbI <sub>2</sub>	50	526.7	1906	Double Salt + KI
9	260	"	64	789.3	2161	"
25	325	"	83.5	1,108.6	2434	"
45	449	"	92	1,273	2566	"
255	751	"	137	2,382	3278	"
731	1186	"	165	4,187	4227	"
569.9	976.4	"	218	10,303	...	"
1411	1521	"	241	12,803	7998	"
2151	1812	"	242	12,749	...	"
2874	2007	"	250	15,264	...	"
5603	2947	"	157	5,218	gms. PbI <sub>2</sub> , KI	PbI <sub>2</sub> , KI, 2H <sub>2</sub> O
...	3339	"	172	6,489	"	"
96.6	1352	" + KI	186	7,903	"	"
114.3	1384	" "	194	9,266	"	"
186.3	1510	" "	201	11,320	"	"

ary solubility method used for temperatures below boiling-point of the  
a and sealed tube (with constriction in middle) method used for tem-  
peratures above boiling point.

liter sat. aqueous solution of iodine dissolves 0.00216 gm. mols. PbI<sub>2</sub> (0.996  
at 20°.

(Fedotieff, 1911-12.)

**SOLUBILITY OF LEAD IODIDE IN ACETONE, ANILINE AND AMYL ALCOHOL.**  
(von Laszczynski, 1894.)

Solvent.	t°.	Gms. PbI <sub>2</sub> per 100 Gms. Solvent.
(CH <sub>3</sub> ) <sub>2</sub> CO	59	0.02
C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub>	13	0.50
C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub>	184	1.10
C <sub>4</sub> H <sub>9</sub> OH	133.5	0.02

**SOLUBILITY OF LEAD IODIDE IN PYRIDINE.**  
(Heise, 1912.)

t°.	Gms. PbI <sub>2</sub> per 100 Gms. Pyridine.	Solid Phase.	t°.	Gms. PbI <sub>2</sub> per 100 Gms. Pyridine.	Solid Phase.
5 f. pt.	...	PbI <sub>2</sub> ·3C <sub>5</sub> H <sub>5</sub> N	35	0.188	PbI <sub>2</sub> ·3C <sub>5</sub> H <sub>5</sub> N
	0.166	"	57	0.190	"
	0.175	"	77	0.228	"
	0.186	"	92	0.290	"
	0.200	"	98	0.340	"
	0.215	"	105	0.370	"
7. pt.	0.225	PbI <sub>2</sub> ·3C <sub>5</sub> H <sub>5</sub> N + PbI <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N	108	0.410	"
	0.208	PbI <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N	112	0.445	"

ns. 95% formic acid dissolve 0.25 gm. PbI<sub>2</sub> at 19.8°. (Aschan, 1913.)

anhydrous hydrazine dissolve 2 gms. PbI<sub>2</sub> at room temp. with decom-  
(Welsh and Broderson, 1915.)

ng-point data for mixtures of lead iodide and silver iodide are given  
bes (1911).

**MALATE** Pb.C<sub>4</sub>H<sub>4</sub>O<sub>6</sub>.3H<sub>2</sub>O.

**SOLUBILITY IN WATER AND ALCOHOL.**  
(Partheil and Hübner, 1903.)

ns. H<sub>2</sub>O dissolve 0.0288 gm. PbC<sub>4</sub>H<sub>4</sub>O<sub>6</sub>.3H<sub>2</sub>O at 18°, and 0.06504 gm. at

ns. 95% alcohol dissolve 0.0048 gm. PbC<sub>4</sub>H<sub>4</sub>O<sub>6</sub>.3H<sub>2</sub>O at 18°-25°.

y of alcohol employed = 0.8092.



# LEAD LAURATE

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## LEAD LAURATE, MYRISTATE, PALMITATE and STEARA

### SOLUBILITY OF EACH IN SEVERAL SOLVENTS.

(Jacobson and Holmes, 1916.)

(See Lithium Laurate, p. 375, for formulas and other details. See also p. 36.)

Solvent.	t°.	Gms. of Each Salt (Determined Separately) Solvent.		
		Pb Laurate.	Pb Myristate.	Pb Palmitate.
Water	35	0.009	0.005	0.005
"	50	0.007	0.006	0.007
Abs. Ethyl Alcohol	25	0.009	0.004	0
" " "	35	0.032	0.004	0.001
" " "	50	0.264	0.052	0.012
Methyl Alcohol	15.5	0.061	0.056	0.051
" "	25	0.096	0.078	0.069
" "	35	0.113	0.082	0.076
" "	50	0.280	0.119	0.093
Ether	14.5	0.010	0.013	0.010
Ethyl Acetate	14	0.017	0.010	0.009
" "	35.5	0.035	0.015	0.009
" "	50	0.201	0.077	0.033
Benzene	15	0.011	0.010	0.009

## LEAD NITRATE Pb(NO<sub>3</sub>)<sub>2</sub>.

### SOLUBILITY IN WATER.

(Mulder; Kremers, 1854; at 15°, Michel and Kraft, 1854; at 17°, Euler, 190

t°.	Grams Pb(NO <sub>3</sub> ) <sub>2</sub> per 100 Gms.			t°.	Grams Pb(NO <sub>3</sub> ) <sub>2</sub> per 1	
	Water.		Solution.		Water.	
0	36.5 <sup>(1)</sup>	38.8 <sup>(2)</sup>	27.33 <sup>(3)</sup>	40	69.4	75
10	44.4	48.3	31.6	50	78.7	85
17	50	54	34.2	60	88	95
20	52.3	56.5	35.2	80	107.6	115
25	56.4	60.6	36.9	100	127	138.8
30	60.7	66	38.8	17	52.76*	

\* Euler.

(1) Mulder, (2) Kremers, (3) Average of M and K.

Density of saturated solution at 17° = 1.405.

100 gms. H<sub>2</sub>O dissolve 55.8 gms. Pb(NO<sub>3</sub>)<sub>2</sub> at 20°. (LeBlanc and

100 gms. H<sub>2</sub>O sat. with Pb(NO<sub>3</sub>)<sub>2</sub> + KNO<sub>3</sub> at 20° dissolve 95.39 gms  
+ 61.05 gms. KNO<sub>3</sub>. (LeBlanc and

100 gms. H<sub>2</sub>O sat. with Pb(NO<sub>3</sub>)<sub>2</sub> + NaNO<sub>3</sub> at 20° dissolve 38.42 gm  
+ 84.59 gms. NaNO<sub>3</sub>. (Le Blanc and

### SOLUBILITY OF LEAD NITRATE IN AQUEOUS SOLUTIONS OF COPPER

AT 20°.

Fedotieff, 1911-12.)

Gms. per 100 Gms. H <sub>2</sub> O.		d <sub>20</sub> of Sat. Sol.	Gms. per 100 Gms. H <sub>2</sub> O.	
Cu(NO <sub>3</sub> ) <sub>2</sub> .	Pb(NO <sub>3</sub> ) <sub>2</sub> .		Cu(NO <sub>3</sub> ) <sub>2</sub> .	Pb(NO <sub>3</sub> ) <sub>2</sub> .
0	55.11	1.419	37.96	13.08
7.7	39.34	1.354	60.32	8.19
15.04	27.80	1.322	83.11	5.37
24.63	19.05	1.321	100.29	3.53
33.25	14.70	1.343	127.70*	2.33*

\* Solid phase in contact with this solution = Pb(NO<sub>3</sub>)<sub>2</sub> + Cu(NO<sub>3</sub>)<sub>2</sub>·6H<sub>2</sub>O.



**SOLUBILITY OF LEAD NITRATE IN CONCENTRATED AQUEOUS SOLUTIONS OF SODIUM NITRATE AND VICE VERSA, DETERMINED BY SYNTHETIC METHOD.**  
(Isaac, 1908.)

(The several mixtures were enclosed in sealed tubes and heated until only one or two very small crystals remained undissolved. The temperature was then determined at which the edges of these crystals just showed a change from sharp to round or vice versa.)

**Results for Lead Nitrate as Solid Phase.**

t° of Saturation.	Gms. per 100 Gms. Sat. Sol.	
	NaNO <sub>3</sub>	Pb(NO <sub>3</sub> ) <sub>2</sub>
32	34.42	19.69
35.5	34.15	20.33
39.5	33.71	21.35
44	33.35	22.19
49.1	32.94	23.15
55	32.60	23.93
58	32.47	24.24
62	32.33	24.57
65	32.19	24.89

**Results for Sodium Nitrate as Solid Phase.**

t° of Saturation.	Gms. per 100 Gms. Sat. Sol.	
	NaNO <sub>3</sub>	Pb(NO <sub>3</sub> ) <sub>2</sub>
21	40.97	13.62
26.5	42.04	13.38
31	43.18	12.88
38.8	44.63	12.78
41	45.11	12.94
44.25	46.03	12.45
51	47.28	12.50
58	49.03	11.76
64	49.92	11.56

**SOLUBILITY OF MIXED CRYSTALS OF LEAD NITRATE AND STRONTIUM NITRATE IN WATER AT 25°.**  
(Fock, 1897.)

Mol. per cent in Solution.		Gms. per 100 cc. Solution.		Sp. Gr. of Solutions.	Mol. per cent in Solid Phase.	
Pb(NO <sub>3</sub> ) <sub>2</sub>	Sr(NO <sub>3</sub> ) <sub>2</sub>	Pb(NO <sub>3</sub> ) <sub>2</sub>	Sr(NO <sub>3</sub> ) <sub>2</sub>		Pb(NO <sub>3</sub> ) <sub>2</sub>	Sr(NO <sub>3</sub> ) <sub>2</sub>
100	0	46.31	0	1.4472	100	0
87.41	12.39	50.47	4.56	1.4336	99.05	0.95
78.68	21.32	53.92	8.14	1.4288	98.11	1.89
56.39	43.61	45.34	17.81	1.4263	97.02	2.98
60.29	39.71	44.48	18.74	1.4245	96.06	3.94
33.70	36.30	25.23	35.03	1.4468	83.84	16.16
24.58	75.42	19.13	37.54	1.4867	32.88	67.12
0	100	0	71.04	1.5141	0	100

**SOLUBILITY OF LEAD NITRATE IN ETHYL AND METHYL ALCOHOL.**

Solvent.	Gms. Pb(NO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Solvent at:				
	4°.	8°.	22°.	40°.	50°.
Aq. C <sub>2</sub> H <sub>5</sub> OH (Sp. Gr. 0.9282)	4.96	5.82	8.77	12.8	14.9 (G)
Aha. C <sub>2</sub> H <sub>5</sub> OH	...	...	0.04 (20.5°)	...	... (de B)
Aha. CH <sub>3</sub> OH	...	...	1.37	...	...

(Gerardin, 1865; de Bruyn, 1892.)

100 cc. anhydrous hydrazine dissolve 52 gms. lead nitrate at room temperature with formation of a yellow precipitate.

(Welsh and Broderson, 1915.)

**SOLUBILITY OF LEAD NITRATE IN PYRIDINE.**

(Walton and Judd, 1911.)

t°.	Gms. Pb(NO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Pyridine.	Solid Phase.	t°.	Gms. Pb(NO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Pyridine.	Solid Phase.
-19.4	2.93	Pb(NO <sub>3</sub> ) <sub>2</sub> ·4C <sub>5</sub> H <sub>5</sub> N	45	22.03	Pb(NO <sub>3</sub> ) <sub>2</sub> ·4C <sub>5</sub> H <sub>5</sub> N
-14.5	2.14	"	49.97	29.37	"
-10	1.90	"	51 tr. pt.	...	" + Pb(NO <sub>3</sub> ) <sub>2</sub> ·3C <sub>5</sub> H <sub>5</sub> N
0	3.54	"	59.52	36.70	Pb(NO <sub>3</sub> ) <sub>2</sub> ·3C <sub>5</sub> H <sub>5</sub> N
5.4	3.93	"	70	47.29	"
8.7	5.39	"	80	61.60	"
14.72	6.13	"	89.93	90.21	"
19.97	6.78	"	94.94	128.06	"
24.75	8.56	"	96 tr. pt.	...	" + 3Pb(NO <sub>3</sub> ) <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N
30.03	10.98	"	99.89	143.36	3Pb(NO <sub>3</sub> ) <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N
34.97	13.20	"	104.90	152	"
40.03	16.04	"	109.90	163.80	"



SOLUBILITY OF LEAD NITRATE-NITRITE,  $\text{Pb}(\text{NO}_3)_2 \cdot \text{Pb}(\text{NO}_2)_2 \cdot 2\text{Pb}(\text{OH})_2$   
IN AQUEOUS SOLUTIONS OF ACETIC ACID AT 13.3°.  
(Chilesotti, 1908.)

Normality of Acetic Acid	Gms. PbO per 100 cc. Sat. Sol.	Normality of Acetic Acid.	Gms. PbO per 100 cc. Sat. Sol.
0	0.601	0.25	5.450
0.05	1.323	0.50	9.690
0.10	2.185	0.75	15.874

### LEAD OXALATE $\text{PbC}_2\text{O}_4$ .

One liter of water dissolves 0.0015 gm.  $\text{PbC}_2\text{O}_4$  at 18° (conduct method).  
(Böttger — Z. physik. Chem. 46, 602, '03; Kohlrausch — *Ibid* 50, 356, '06.)

### LEAD OXIDES.

#### SOLUBILITY IN WATER.

(Böttger; Ruer — Z. anorg. Chem. 50, 273, '06.)

No.	Description of Oxide.	Gm. Equiv. per Liter.
1.	Yellow Oxide, by boiling Pb hydroxide with 10% NaOH	$1.03 \times 10^{-4}$
2.	Red Oxide, by boiling Pb hydroxide with conc. NaOH	$0.56 \times 10^{-4}$
3.	Yellow Oxide, by heating No. 1 to 630°	$1.05 \times 10^{-4}$
4.	Yellow Oxide, by heating No. 2 to 740°	$1.00 \times 10^{-4}$
5.	Yellow Oxide, by heating com. yellow brown oxide to 620°	$1.09 \times 10^{-4}$
6.	Yellow Brown Oxide commercially pure	$1.10 \times 10^{-4}$
7.	Yellow Brown Oxide, by long rubbing of No. 5.	$1.12 \times 10^{-4}$

Böttger gives for three samples of lead oxide, 0.017, 0.021, and gm. per liter respectively.

One liter  $\text{H}_2\text{O}$  dissolves 0.068 gm. PbO at 18°, solid phase PbO and 0.10 PbO at 18°, solid phase  $\text{Pb}_2\text{O}_3(\text{OH})_2$ .  
(Pleissner)

Results for the solubility of hydrated lead oxide in water and dilute solutions are given by Sehnal (1909). The results are considerably higher than the above, viz. 0.1385 gm. Pb per 1000 cc.  $\text{H}_2\text{O}$  at 20°; with increase of the solubility decreases rapidly.

100 cc. anhydrous hydrazine dissolve 1 gm. lead oxide (red) at room temperature.  
(Welsh and Brodersen)

Freezing-point lowering data for mixtures of  $\text{PbO} + \text{PbSO}_4$  are given by Schenck and Rassbach, 1908. Data for mixtures of  $\text{PbO} + \text{SiO}_2$  are given by Weiller, 1911, and by Cooper, Shaw and Loomis, 1909.

### LEAD Peroxide $\text{PbO}_2$ .

The two forms of lead superoxide, (a) amorphous and (b) crystalline in their solubilities in sulphuric acid. One liter of very concentrated  $\text{H}_2\text{SO}_4$  dissolves about 0.010 mol.  $\text{PbO}_2$  (b) at 22°. One liter of conc.  $\text{H}_2\text{SO}_4$  containing 1720 gms. per liter, dissolves 0.0995 mol.  $\text{PbO}_2$  (a) at 22°. The solid is slowly converted to  $\text{Pb}(\text{SO}_4)_2$ . One liter of  $\text{H}_2\text{SO}_4$  containing 1097 gms. per liter dissolves 0.004 mol.  $\text{PbO}_2$  at 22°. The solid phase is converted quickly to  $\text{Pb}(\text{SO}_4)_2$ . In more dilute  $\text{H}_2\text{SO}_4$  solutions no solubility can be detected.  
(Dolezalek and Finck)

### LEAD PALMITATE, LEAD STEARATE. See also p. 360.

100 cc. absolute ether dissolve 0.0138 gm. palmitate and 0.0148 gm. stearate.  
(Lido)

### LEAD Tetraphenyl $\text{Pb}(\text{C}_6\text{H}_5)_4$ .

Freezing-point data for  $\text{Pb}(\text{C}_6\text{H}_5)_4 + \text{Si}(\text{C}_6\text{H}_5)_4$  are given by Pascal (1911).

### LEAD PHOSPHATE (Ortho) $\text{Pb}_3(\text{PO}_4)_2$ .

One liter water dissolves 0.000135 gm. lead phosphate at 20° by conduct method.  
(Böttger)

One liter of 4.97 per cent aqueous acetic acid solution dissolves 1.2 gm.  $\text{Pb}_3(\text{PO}_4)_2$ .  
(Bertram)



**LEAD SUCCINATE  $\text{PbC}_4\text{H}_4\text{O}_6$** **SOLUBILITY IN WATER AND IN ALCOHOL.**

(Partheil and Hübner, 1903.)

100 gms.  $\text{H}_2\text{O}$  dissolve 0.0253 gm.  $\text{PbC}_4\text{H}_4\text{O}_6$  at  $18^\circ$ , and 0.0285 gm. at  $25^\circ$ .  
 100 gms. 95% alcohol dissolve 0.00275 gm.  $\text{PbC}_4\text{H}_4\text{O}_6$  at  $18^\circ$ , and 0.003 gm. at  $25^\circ$ .

Density of alcohol used = 0.8092.

**SOLUBILITY OF LEAD SUCCINATE IN WATER.**

(Cantoni and Diotalevi, 1905.)

$t^\circ$ .	10°.	21°.	32°.	39°.	50°.
Gms. $\text{PbC}_4\text{H}_4\text{O}_6$ per 100 cc. sat. sol.	0.015	0.019	0.024	0.027	0.029

**LEAD SULFATE  $\text{PbSO}_4$** **SOLUBILITY IN WATER.**

(Average curve from gravimetric results of Dibbits (1874), Beck and Stegner (1910) and Pleissner (1907) and conductivity results of Böttger (1903) and Kohlrausch (1904-05).)

$t^\circ$ .	Gms. $\text{PbSO}_4$ per Liter.	$t^\circ$ .	Gms. $\text{PbSO}_4$ per Liter.
0	0.028	20	0.041
5	0.031	25	0.045
10	0.035	30	0.049
15	0.038	35	0.052
18	0.040	40	0.056

Results considerably higher than the above are reported by Sehna (1909). The author finds 0.082 gm.  $\text{PbSO}_4$  per liter at  $18^\circ$  and claims that the presence of  $\text{H}_2\text{SO}_4$  in the  $\text{PbSO}_4$  reduces the solubility very greatly. His results for the solubility in presence of small amounts of  $\text{H}_2\text{SO}_4$  are:

a. $\text{H}_2\text{SO}_4$ per 1000 cc. solution	0	0.0098	0.0196	0.0980	0.4900	0.9800
a. dissolved $\text{PbSO}_4$ per 1000 cc. solution at $20^\circ$	0.082	0.051	0.025	0.013	0.006	0

Sehna also gives results showing that the solubility in water and dilute  $\text{H}_2\text{SO}_4$  solutions is exactly the same at  $100^\circ$  as at  $20^\circ$ .

Data for the solubility of  $\text{PbSO}_4$  precipitates are given by deKoninck, 1907.

**SOLUBILITY OF LEAD SULFATE IN AQUEOUS SOLUTIONS OF AMMONIUM ACETATE AND OF SODIUM ACETATE.**

(Noyes and Whitcomb, 1905; Dunnington and Long, 1899; Dibbits, 1874.)

**In Ammonium Acetate.****In Sodium Acetate.**

At $25^\circ$ (N. and W.).				At $100^\circ$ (D. and L.).			
Gms. per Liter.		Gms. per Liter.		G. $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$ per 100 cc. Solution.		G. $\text{PbSO}_4$ per 100 g. Solution.	
$\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$	$\text{PbSO}_4$	$\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$	$\text{PbSO}_4$			$\text{NaC}_2\text{H}_3\text{O}_2$	$\text{PbSO}_4$
0	0.134	0	0.041	28	7.12	2.05	0.054
103.5	2.10	7.98	0.636	32	9.88	8.2	0.853
207.1	4.55	15.96	1.38	37	10.58	41	11.23
414.1	10.10	31.92	3.02	45	11.10		

**SOLUBILITY OF LEAD SULFATE IN AQUEOUS SOLUTIONS OF AMMONIUM ACETATE AT  $25^\circ$ .**

(Marden, 1916.)

Gms. per 1000 $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$	Gms. Sat. Sol. $\text{PbSO}_4$	Gms. per 1000 $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$	Gms. Sat. Sol. $\text{PbSO}_4$	$d_{25}$ of Sat. Sol.
7.96	0.636	53.4	5.60	1.012
15.91	1.370	106.8	10.8	1.024
31.70	3.04	213.7	38.9	1.045



# LEAD SULFATE

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## SOLUBILITY OF LEAD SULFATE IN AQUEOUS SOLUTIONS OF POTASSIUM AND OF SODIUM ACETATE AT 25°. (Fox, 1909.)

In Aq. Potassium Acetate.			In Aq. Sodium Acetate.		
Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		
$\text{CH}_3\text{COOK} \cdot (\text{CH}_3\text{COO})_2\text{Pb}$			$\text{CH}_3\text{COONa} \cdot (\text{CH}_3\text{COO})_2\text{Pb}$		$\text{Na}_2\text{SO}_4$
4.33	2.54	$\text{PbSO}_4 + \text{PbK}_2(\text{SO}_4)_2$	6.69	0.78	0.34
9.03	3.55	"	6.95	0.81	0.35
17.81	5.43	"	11.76	2.73	1.26
26.58	9.83	"	16.90	5.70	2.49
28.82	11.40	"	19.92	8.24	3.60
28.93	19.41	"	21.51	10.75	4.68

In the case of the  $\text{CH}_3\text{COOK}$  solutions, the double salt  $\text{PbK}_2(\text{SO}_4)_2$  is formed and no  $\text{SO}_4$  ions enter the solution.

## SOLUBILITY OF LEAD SULFATE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC AND OF NITRIC ACIDS AND OF SODIUM CHLORIDE. (Beck and Stegmüller, 1910.)

In Aqueous HCl.				In Aq. $\text{HNO}_3$ at 18°.		In Aq. NaCl at 18°.	
Normality of HCl.	Milligrams Pb per 100 cc. Solution.			Normality of $\text{HNO}_3$ .	Mgm. Pb per 100 cc. Sol.	Normality of NaCl.	Mgm. per 100 cc.
o (=pure $\text{H}_2\text{O}$ )	At 18°.	At 25°.	At 37°.				
	2.60	3	3.80	0.1	10.48	0.1	11.
0.1	19	22.18	28.04	0.2	17.48	0.2	18.
0.2	35.70	42.88	54.50	0.3	23.41	0.3	26.
0.3	55.37	65.15	84.04	0.4	29.84	0.4	33.
0.4	75.27	88.80	111.90				

## SOLUBILITY OF LEAD SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 18°. (Pleissner, 1907.)

(See also Sehna, preceding page.)

Gms. per Liter.		Millimols per Liter.		Gms. per Liter.		Millimols per Liter.	
$\text{H}_2\text{SO}_4$ .	$\text{PbSO}_4$ .	$\text{H}_2\text{SO}_4$ .	$\text{PbSO}_4$ .	$\text{H}_2\text{SO}_4$ .	$\text{PbSO}_4$ .	$\text{H}_2\text{SO}_4$ .	$\text{PbSO}_4$ .
0	0.0382	0	0.126	0.0245	0.0194	0.25	0.
0.0049	0.0333	0.05	0.110	0.0490	0.0130	0.50	0.
0.0098	0.0306	0.10	0.101	0.4904	0.0052	5	0.

## SOLUBILITY OF LEAD SULFATE IN CONCENTRATED AQUEOUS SOLUTIONS OF HYDROCHLORIC AND OF NITRIC ACIDS. (Schultz, 1861; Rodwell, 1862.)

In Aq. $\text{H}_2\text{SO}_4$ .			In Aq. HCl.			In Aq. $\text{HNO}_3$	
(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)
1.540	63.4	0.003	1.05	10.6	0.14	1.08	11.6
1.793	85.7	0.011	1.08	16.3	0.35	1.12	17.5
1.841	97	0.039	1.11	22	0.95	1.25	34
			1.14	27.5	2.11	1.42	60
			1.16	31.6	2.86		

(a) Sp. Gr. of Aq. Acid. (b) Gms. Acid per 100 Gms. Solution. (c) Gms.  $\text{PbSO}_4$  per 100 Gms. Solution.

## SOLUBILITY OF LEAD SULFATE IN CONC. SOLUTIONS OF SULFURIC ACID (Donk, 1916.)

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.	
	$\text{H}_2\text{SO}_4$ .	$\text{PbSO}_4$ .			$\text{H}_2\text{SO}_4$ .	$\text{PbSO}_4$ .
0	51.2	0	$\text{PbSO}_4$	100	61.2	0
0	89.4	0	" + $\text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$	100	72.5	0.1
0	97	0	$\text{H}_2\text{SO}_4$	100	96.3	0.2
0	97.2	0.3	" + $\text{PbSO}_4$	100	99.1	0.9
50	50.4	0	$\text{PbSO}_4$	200	79	0
50	86.7	0.1	"	200	88.8	0.1
50	95.1	0.2	"	200	95.5	0.3
50	99.3	0.6	"	200	98.9	1.1

Additional data for highly concentrated solutions of  $\text{H}_2\text{SO}_4$  are given by Donk and Kanhäuser (1916).



# SOLUBILITY OF BASIC LEAD SULFATES IN WATER AT 18°.

(Pleissner, 1907.)

Pound.	Formula.	One Liter Sat. Solution Contains:		
		Mg. Lead Salt =	Mg. Pb =	Millimols Pb.
Lead Sulfate	$\text{PbSO}_4 \cdot \text{PbO}$	13.4	10.6	0.050
Lead Sulfate	$\text{PbSO}_4 \cdot 3\text{PbO} \cdot \text{H}_2\text{O}$	26.2	22	0.106

# LEAD SULFATE $\text{Pb}(\text{SO}_4)_2$ .

## SOLUBILITY IN AQUEOUS SULFURIC ACID AT 22°.

(Dolezalek and Finckli, 1906.)

Gms. per Liter.	Solid Phase.	Gms. per Liter.		Solid Phase.
		$\text{H}_2\text{SO}_4$ .	$\text{Pb}(\text{SO}_4)_2$ .	
0	$\text{PbOSO}_4 \cdot \text{H}_2\text{O}$	1253	14.85	$\text{PbOSO}_4 \cdot \text{H}_2\text{O}$
0.719	"	1352	16.17	"
1.198	"	1470	9.30	$\text{Pb}(\text{SO}_4)_2$
1.557	"	1532	9.46	"
2.115	"	1631	19.80	"
5.749	"	1698	33.34	"
9.303	"	1703	35.22	"

solid phase at concentrations of acid up to 1352 gms. per liter is the white of the composition  $\text{PbOSO}_4 \cdot \text{H}_2\text{O}$ . In the concentration limits of 1352-1703 gms.  $\text{H}_2\text{SO}_4$  per liter the original yellow color of the solid phase is unchanged.

Freezing-point data (solubility, see footnote, p. 1) for mixtures of  $\text{PbSC}_2 + \text{Li}_2\text{SO}_4$ ,  $\text{K}_2\text{SO}_4$  and  $\text{PbSO}_4 + \text{Na}_2\text{SO}_4$  are given by Calcagni and Mariotta (1912). Freezing-point data for mixtures of  $\text{PbSO}_4 + \text{K}_2\text{SO}_4$  are also given by Grahmann, 1913.

# (HYPO)SULFATE.

## FREEZING-POINT DATA FOR MIXTURES OF LEAD HYPOSULPHATE AND STRONTIUM HYPOSULPHATE AT 25°.

(Fock — Z. Kryst. Min. 28, 389, '97.)

In Solution.	Grams per Liter.		Sp. Gr. of Solutions.	Mol. per cent in Solid Phase.	
	$\text{PbSO}_4$ .	$\text{SrSO}_4$ .		$\text{PbSO}_4$ .	$\text{SrSO}_4$ .
$\text{PbSO}_4$ .					
100.0	0.0	145.6	1.1126	0.0	100.0
98.95	2.97	151.2	1.1184	0.30	99.7
84.69	40.82	152.5	1.1503	3.87	96.13
53.20	149.2	114.5	1.2147	9.84	90.16
37.70	256.1	85.0	1.2889	19.26	80.74
24.25	310.3	67.0	1.3252	23.73	76.27
21.91	373.7	70.8	1.3726	32.24	67.76
11.71	509.5	45.6	1.4671	49.97	50.13
0.00	374.3	0.0	1.6817	0.00	0.00

# LEAD SULFIDE $\text{PbS}$ .

$\text{H}_2\text{O}$  dissolves  $3.6 \cdot 10^{-4}$  gm. Mols. = 0.00086 gm.  $\text{PbS}$  at 18°. (Weigel, 1907.) Determined by conductivity method. See also Bruner and Zawadzki (1909). Freezing-point diagrams for  $\text{PbS} + \text{ZnS}$  and  $\text{PbS} + \text{Ag}_2\text{S}$  are given by Friedrich (1912). Freezing-point results for  $\text{PbS} + \text{Sb}_2\text{S}_3$  are given by Wagemmann (1912).

# LEAD SULFONATES.

## SOLUBILITY IN WATER.

Name.	Formula.	Gms. Salt per 100 Gms. $\text{H}_2\text{O}$ .	Authority.
Diiodobenzenesulfonate	$\text{C}_6\text{H}_4\text{O}_4\text{I}_2\text{S} \cdot \text{Pb} \cdot 4\text{H}_2\text{O}$	20 0.77	(Boyle, 1909.)
Phthalene Sulfonate	$(\text{C}_8\text{H}_7\text{SO}_3)_2 \cdot \text{Pb} \cdot \text{H}_2\text{O}$	25 0.4	(Witte, '15; Euwens, '09.)
"	$(\text{C}_8\text{H}_7\text{SO}_3)_2 \cdot \text{Pb} \cdot 2\text{H}_2\text{O}$	24.9 4.105	(Euwens, 1909.)
Anthracene Monosulfonate	$\text{H}_2\text{O}$	20 0.014	(Sandquist, 1912.)
"	$3\text{H}_2\text{O}$	20 0.08	"
"	$4\text{H}_2\text{O}$	20 0.14	"



## LEAD TARTRATE

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## LEAD TARTRATE $\text{PbC}_2\text{O}_4\text{H}_4$ .

### SOLUBILITY IN WATER.

(Cantoni and Zachoder — Bull. soc. chim. [3] 33, 751, '05; Partheil and Hübner — Archiv. Pharm. 244, 413, '03.)

t°.	Gms. $\text{PbC}_2\text{O}_4\text{H}_4$ per 100 cc. Solution.	t°.	Gms. $\text{PbC}_2\text{O}_4\text{H}_4$ per 100 cc. Solution.	t°.	Gms. $\text{PbC}_2\text{O}_4\text{H}_4$ per 100 cc. Solution.
18	0.010 (P. and H.)	50	0.00225	70	0.0032
25	0.0108 "	55	0.00295	75	0.0033
35	0.00105	60	0.00305	80	0.0038
40	0.0015	65	0.00315	85	0.0054

NOTE. — The positions of the decimal points here shown are just as given in the original communications.

100 gms. alcohol of 0.8092 Sp. Gr. (about 95%) dissolve 0.0028 gm.  $\text{PbC}_2\text{O}_4\text{H}_4$  at 18°, and 0.00315 gm. at 25°. (P. and H.)

## LECITHIN $\text{C}_{48}\text{H}_{84}\text{NPO}_8$ .

100 gms. of sat. solution in aqueous 5% bile salts contain 4.5 gms. lecithin at 15°–20° and 7 gms. at 37°. Lecithin is practically insoluble in water.

(Moore, Wilson and Hutchinson, 1909)

## LEUCINE $\text{CH}_3(\text{CH}_2)_3\text{CH}(\text{NH}_2)\text{COOH}$ .

100 cc.  $\text{H}_2\text{O}$  dissolve 2.2 gms. leucine at 18°.

100 cc. alcohol dissolve 0.06 gm. leucine at 17°.

Data for the solubility of leucine in aqueous solutions of salts at 20° are given by Würzler, 1914, and Pfeiffer and Würzler, 1916.

## LIGNOCERIC ACID.

Data for the freezing-points (solubility, see footnote, p. 1) of mixtures lignoceric acid and other compounds are given by Meyer, Brod and Soyka, 1914.

## LIGRÖIN.

100 cc.  $\text{H}_2\text{O}$  dissolve 0.341 cc. ligröin at 22°, Vol. of solution = 100.34, Sp. 0.9969.

100 cc. ligröin dissolve 0.335 cc.  $\text{H}_2\text{O}$  at 22°, Vol. of solution = 100.60, Sp. 0.6640. (Herr, 2)

## LITHIUM Li.

One gm. atom Li dissolves in 3.93 gm. mols.  $\text{NH}_3$  at  $-80^\circ$ , at  $-50^\circ$ , at  $-$  and at  $0^\circ$ . (Ruff and Geisel, 11)

## LITHIUM ACETATE $\text{CH}_3\text{COOLi}\cdot 2\text{H}_2\text{O}$ .

Freezing-point data for mixtures of lithium acetate and acetic acid are given by Vasilev, 1909.

## LITHIUM SulfoANTIMONATE $\text{Li}_3\text{SbS}_4\cdot 10\text{H}_2\text{O}$ .

### SOLUBILITY IN WATER AND IN AQUEOUS ALCOHOL.

In Water. (Donk, 1908.)			In Aqueous Alcohol at 10° and 30°.			
t°.	Gms. $\text{Li}_3\text{SbS}_4$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.	Authority
				$\text{C}_2\text{H}_5\text{OH}$ $\text{Li}_3\text{SbS}_4$		
— 1.7	7.1	Ice	10	10.7   41.8	$\text{Li}_3\text{SbS}_4\cdot 10\text{H}_2\text{O}$	(Donk, 1908)
— 3.2	12.8	"	10	26.2   36.5	"	"
— 5.1	17.5	"	10	66.2   20.6	"	"
— 10.8	23.2	"	30	13.3   46.3	$\text{Li}_3\text{SbS}_4\cdot 8\frac{1}{2}\text{H}_2\text{O}$	(Schreinemakers, Jacobs, 1910.)
— 15.9	28.5	"	30	51.9   30.7	"	
— 26.2	35.3	"	30	54.8   29.9	"	
— 42	40.4	Ice + $\text{Li}_3\text{SbS}_4\cdot 10\text{H}_2\text{O}$	30	58.4   30.8	"	
0	45.5	$\text{Li}_3\text{SbS}_4\cdot 10\text{H}_2\text{O}$	30	58.6   32.3	" + $\text{Li}_3\text{SbS}_4$	
+ 10	46.9	"	30	65.26   29.31	$\text{Li}_3\text{SbS}_4$	
30	50.1	"	30	74.3   24.1	"	
50	51.3	"	30	79.5   20.5	"	



**I BENZOATE**  $C_6H_5COOLi$ .

## SOLUBILITY IN AQUEOUS ALCOHOL SOLUTIONS AT 25°.

(Seidell, 1910.)

$d_m$ of Sat. Sol.	Gms. $C_6H_5COOLi$ per 100 Gms. Sat. Sol.	Per cent $C_6H_5OH$ in Solvent.	$d_m$ of Sat. Sol.	Gms. $C_6H_5COOLi$ per 100 Gms. Sat. Sol.
1.103	27.64	60	0.970	19.80
1.088	28.60	70	0.932	15.40
1.072	28.50	80	0.890	10.70
1.052	27.80	90	0.847	6.40
1.030	26.20	95	0.823	4.50
1.003	23.60	100	0.799	2.60

1.  $H_2O$  dissolve about 40 gms.  $C_6H_5COOLi$  at the b. pt. (U.S.P.)2. alcohol dissolve about 10 gms.  $C_6H_5COOLi$  at the b. pt. "**II BORATE**  $Li_2OB_2O_3$ .

## SOLUBILITY IN WATER.

$t^\circ$	0	10	20	30	40	45
$Li_2OB_2O_3$ per 100 Gms. $H_2O$	0.7	1.4	2.6	4.9	11.12	20

(Le Chatelier, 1897.)

## SOLUBILITY IN THE SYSTEM LITHIUM OXIDE, BORIC OXIDE, WATER AT 30°.

(Dukelski, 1907.)

Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
$B_2O_3$		$Li_2O$	$B_2O_3$
...	$LiOH \cdot H_2O$	1.32	3.36
2.98	"	0.86	2.47
3.38	" + $Li_2O \cdot B_2O_3 \cdot 16H_2O$	0.53	2.47
3.56	$Li_2O \cdot B_2O_3 \cdot 16H_2O$	2.17	13.12
2.78	"	2.61	16.39
2.42	"	5.08	30.81
2.51	"	4.10	27.07
3.27	"	3.22	15.40
6.90	"	1.55	15.40
14.78	"	1.30	14.14
22	"	0.96	11.47
23.8	"	0.63	4.85
6.20	$Li_2O \cdot 2B_2O_3 \cdot 5H_2O$	0	3.54

g-point data (solubility, see footnote, p. 1) for mixtures of  $LiBO_2$ , and  $LiBO_2 + Li_2SiO_3$  are given by van Klooster, 1910-11.**III BROMATE**  $LiBrO_3$ .1.  $H_2O$  dissolve 153.7 gms.  $LiBrO_3$  at 18°, or 100 gms. saturated solution 60.4 gms. Sp. Gr. of sol. = 1.833. (Mylius and Funk, 1897.)**IV BROMIDE**  $LiBr \cdot 2H_2O$ .

## SOLUBILITY IN WATER.

(Kremers, 1858; Bogorodsky, 1894; Jones, 1907.)

Gms. $LiBr$ per 100 Gms. $H_2O$ .	Solid Phase.	$t^\circ$ .	Gms. $LiBr$ per 100 Gms. $H_2O$ .	Solid Phase.
6	1.058	Ice (J)	10	166
4	4.274	"	20	177
7	8.678	"	30	191
	17.80	"	40	205
	37.64	"	44	209
	50	" + $LiBr \cdot 3H_2O$	50	214
	80	$LiBr \cdot 3H_2O$	60	224
	122	"	80	245
	143	" (K)	100	266
	160	" + $LiBr \cdot 2H_2O$ (B)	159	...

g-point data for  $LiBr + LiOH$  (Scarpa, 1915), for  $LiBr + AgBr$ .1. glycol dissolve 60 gms.  $LiBr$  at 14.7°. (Sandonnini and Scarpa, 1913.) (de Coninck, 1905.)



**DILITHIUM *d* CAMPHORATE**  $C_{10}H_{16}O_4Li_2$ .

SOLUBILITY IN AQUEOUS SOLUTIONS OF CAMPHORIC ACID AT  $13.5^{\circ}$ — $16^{\circ}$   
AND VICE VERSA.

(Jungfleisch and Landrieu, 1914.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	
$C_6H_{14}(COOH)_2$ .	$C_{10}H_{16}O_4Li_2$ .		$C_6H_{14}(COOH)_2$
0.621	0	Camphoric Acid	"
2.02	3.77	"	"
3.25	10.63	Monolithium Tetracamphorate	$C_{10}H_{16}O_4Li_3C_6H_5O_4$
3.51	12.61	"	"
3.99	20.56	" Dicumphorate	$C_{10}H_{16}O_4Li_2C_6H_5O_4$
3.43	24.69	"	"
2.87	37.16	" Camphorate	$C_{10}H_{16}O_4Li$
0	40.80	Dilithium Camphorate	$C_{10}H_{16}O_4Li_2$

The mixtures were kept in a cellar at nearly constant temperature and shaken from time to time until equilibrium was reached. Additional results at  $17^{\circ}$ — $23^{\circ}$  are also given.

**LITHIUM CARBONATE**  $Li_2CO_3$ .

SOLUBILITY IN WATER.

(Bevade, 1885; Flückiger, 1887; Draper, 1887.)

An average curve was constructed from the available results and the following table read from it.

t.°.	Gms. $Li_2CO_3$ per 100 Gms.		t.°.	Gms. $Li_2CO_3$ per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	1.54	1.52	40	1.17	1.16
10	1.43	1.41	50	1.08	1.07
20	1.33	1.31	60	1.01	1.00
25	1.29	1.28	80	0.85	0.84
30	1.25	1.24	100	0.72	0.71

Density of saturated solution at  $0^{\circ}$  = 1.017; at  $15^{\circ}$  = 1.014.

SOLUBILITY OF LITHIUM CARBONATE IN AQUEOUS SOLUTIONS OF  
ALKALI SALTS AT  $25^{\circ}$ .

(Geffcken — Z. anorg. Chem. 43, 197, '05.)

The original results were calculated to gram quantities and plotted on cross-section paper. The figures in the following table were read from the curves.

Gms. Salt per Liter.	Grams $Li_2CO_3$ per Liter in Aqueous Solutions of:							
	KClO <sub>3</sub> .	KNO <sub>3</sub> .	KCl.	NaCl.	K <sub>2</sub> SO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	NH <sub>4</sub> Cl.	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .
0	12.63	12.63	12.63	12.63	12.63	12.63	12.63	12.63
10	12.95	13.05	13.10	13.4	13.9	14.0	16.0	20.7
20	13.10	13.3	13.5	13.9	14.7	15.0	19.2	25.0
30	13.25	13.6	13.8	14.3	15.4	16.0	21.5	28.2
40	13.40	13.8	14.0	14.6	16.0	16.6	23.3	30.8
60	...	13.8	14.2	14.5	16.9	17.8	26.0	35.2
80	...	13.6	14.0	14.4	17.7	18.6	27.6	38.5
100	...	13.5	13.9	14.2	18.2	19.4	28.4	41.0
120	...	13.3	13.7	14.0	...	19.9	28.7	42.6
140	...	13.0	13.3	...	...	20.4	28.8	43.5
170	...	12.6	...	...	...	...	28.9	...
200	...	12.2	...	...	...	...	29.0	...

100 gms. aq. alcohol of 0.941 Sp. Gr. dissolve 0.056 gm.  $Li_2CO_3$  at  $15.5^{\circ}$ .

One liter sat. sol. in water contains 0.1722 gm. mols. = 12.73 gms.  $Li_2CO_3$  at  $2^{\circ}$  (Ageno and Valla, 1914)



# SOLUBILITY OF LITHIUM CARBONATE IN AQUEOUS SOLUTIONS OF ORGANIC COMPOUNDS AT 25°.

(Rothmund, 1908, 1910; see also Traube, 1909.)

Solubility in  $H_2O$  = 0.1687 mols.  $Li_2CO_3$  per liter = 12.47 gms. at 25°.

Aqueous Solution of:	Gm. Mols. $Li_2CO_3$ per Liter in Aq. Solution of:			
	0.125 Normality.	0.25 Normality.	0.5 Normality.	1 Normality.
Alcohol	...	0.1604	0.1529	0.1394
Alcohol	0.1614	0.1555	0.1417	0.1203
Alcohol	0.1604	0.1524	0.1380	0.1097
Alcohol (tertiary)	0.1564	0.1442	0.1224	0.0899
	0.1600	0.1515	0.1366	0.1104
	0.1580	0.1476	0.1300	...
Acetone	0.1668	0.1653	0.1606	0.1531
	0.1660	0.1629	0.1565	0.1472
	0.1670	0.1647	0.1613	0.1532
	0.1705	0.1737	0.1778	...
Acetone	0.1702	0.1728	0.1752	0.1778
Acetone	0.1693	0.1689	0.1661	0.1557
	0.1686	0.1673	0.1643	0.1605
	0.1667	0.1643	0.1600	0.1523
Acetone	0.1562	0.1460	0.1280	0.0992
	0.1653	0.1630	0.1577	0.1466
Acetone	0.1589	0.1481	0.1283	0.0937
	0.1592	0.1503	0.1347	0.1091
	0.1604	0.1525	0.1377	0.1113
	...	0.1614	0.1520	0.1358
Acetone	0.1618	0.1556	0.1429	0.1178
Acetone	0.1697	0.1704	...	...

Freezing-point data for mixtures of  $Li_2CO_3$  +  $Li_2SO_4$   
+  $K_2CO_3$ .

(Amadori, 1912.)  
(Le Chatelier, 1894.)

## I (Bi) CARBONATE $LiHCO_3$ .

1.  $H_2O$  dissolve 5.501 gms.  $LiHCO_3$  at 13°.

(Bevade, 1884.)

## I CHLORATE $LiClO_3$ .

1.  $H_2O$  dissolve 213.5 gms.  $LiClO_3$  at 18°, or 100 gms. sat. solution contains 18.15 gms. Sp. Gr. of sol. = 1.815.

(Mylius and Funk, 1897.)

2.  $H_2O$  dissolve 483 gms.  $LiClO_3$  at 15°,  $d_{15}$  of sat. sol. = 1.82. (Carlson, 1910.)

## I CHLORAUROATE $LiAuCl_4$ .

### SOLUBILITY IN WATER. (Rosenbladt, 1886.)

Gms. $LiAuCl_4$ per 100 Gms. Solution.	t°.	Gms. $LiAuCl_4$ per 100 Gms. Solution.	t°.	Gms. $LiAuCl_4$ per 100 Gms. Solution.
53.1	40	67.3	60	76.4
57.7	50	72	70	81
62.5			80	85.7



# LITHIUM CHLORIDE

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## LITHIUM CHLORIDE LiCl.

SOLUBILITY IN WATER. (Average curve from results of Gerlach, 18

t°.	Gms. LiCl per 100 Gms.		t°.	Gms. LiCl per 100	
	Water.	Solution.		Water.	S
0	67	40.1	40	90.5	
10	72	41.9	50	97	
20	78.5	44	60	103	
25	81.5	44.9	80	115	
30	84.5	45.8	100	127.5	

Density of saturated solution at 0°, 1.255; at 15°, 1.275.

## SOLUBILITY OF LITHIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID.

Results at 0°. (Engel, 1888.)			Results at 25°. (Herr	
Gms. per 100 cc. Sat. Sol.		d <sub>4</sub> of Sat. Sol.	Gms. per 100 cc. Sat	
LiCl.	HCl.		LiCl.	
51	0	1.255	57.4	0
41.4	8.2	1.243	56.87	2
28.5	24.1	1.249	53.64	3
24.6	29.5	1.251	51.98	6

## SOLUBILITY OF LITHIUM CHLORIDE IN AQUEOUS SOLUTIONS OF ALCOHOL. (Pinar de Rubies, 1913-1914.)

The LiCl was determined by titration with AgNO<sub>3</sub>. Solutions constant agitation for many hours. Solid phase, LiCl.H<sub>2</sub>O for ; The anhydride, LiCl, separates only from the most highly concent solutions.

Gms. per 100 Gms. Sat Sol.		Gms. per 100 Gms. Sat. Sol.	
C <sub>2</sub> H <sub>5</sub> OH.	LiCl.	C <sub>2</sub> H <sub>5</sub> OH.	LiCl.
0	44.9	50	25.75
10	40.9	60	21.6
20	37.25	70	21.1
30	33.3	75	20.8
40	29.4	80	20.75

## SOLUBILITY OF LITHIUM CHLORIDE IN ETHYL ALCOHOL AT DIFFERENT TEMPERATURES. (Turner and Bissett, 1913.)

t°.	Gms. LiCl per 100 Gms. C <sub>2</sub> H <sub>5</sub> OH.	Solid Phase.	t°.	Gms. LiCl per 100 Gms. C <sub>2</sub> H <sub>5</sub> OH.
0	14.42	LiCl.4C <sub>2</sub> H <sub>5</sub> OH	20	24.28
5	15.04	"	30	25.10
10	16.77	"	40	25.38
15	18.79	"	50	24.40
17	20.31	"	60	23.46

## SOLUBILITY OF LITHIUM CHLORIDE IN SEVERAL SOLVENTS.

Gms. LiCl per 100 Gms. Solvent.			Gms. LiCl per 100 Gms. Solvent.		
Solvent.		Authority.	Solvent.		Authority.
Alcohol:			Alcohol:		
Methyl	25	42.36 (Turner & Bissett, 1913.)	Amyl	25	9.03 (Turner
Ethyl	25	2.54* (Patten & Mott, 1904.)	"	?	7.2 (Andrew
Propyl	25	16.22 (Turner & Bissett, 1913.)	"	25	9* (Patten
"	?	15.86 (Schlamp, 1894.)	Butyl	25	10.57* "
"	25	3.86* (Patten & Mott, 1904.)	Glycerol	25	4.32* "
Allyl	25	4.38* "	Phenol	53	1.93* "

\* Fused LiCl used for these determinations.

100 cc. anhydrous hydrazine dissolve 16 gms. LiCl at room temp. (Welsh and I



**SOLUBILITY OF LITHIUM CHLORIDE IN SEVERAL SOLVENTS.**  
(Laszczynski, 1894; deConinck, 1905.)

°.	In Acetone. (L.)			In Pyridine. (L.)			In Glycol. (de C.)		
	Gms. LiCl per 100 Gms. (CH <sub>3</sub> ) <sub>2</sub> CO.	t°.	Gms. LiCl per 100 Gms. (CH <sub>3</sub> ) <sub>2</sub> CO.	t°.	Gms. LiCl per 100 Gms. C <sub>2</sub> H <sub>5</sub> N.	t°.	Gms. LiCl per 100 Gms. Sat. Sol.	t°.	Gms. LiCl per 100 Gms. Sat. Sol.
0	4.60	46	3.76	15	7.78	15	11		
12	4.41	53	3.12	100	14.26				
25	4.11	58	2.14						

**SOLUBILITY OF LITHIUM CHLORIDE IN PYRIDINE.**  
(Kahlenberg and Krauskopf, 1908.)

In Anhydrous Pyridine.				In 97% Pyridine + 3% H <sub>2</sub> O by Volume.			
t°.	Gms. LiCl per 100 Gms.		Solid Phase.	t°.	Gms. LiCl per 100 Gms.		
	Sat. Sol.	Solvent.			Sat. Sol.	Solvent.	
8	11.31	12.71	LiCl·2C <sub>5</sub> H <sub>5</sub> N	22	12.50	14.31	
28	11.87	13.47	"	32	13.79	15.98	
40	11.60	13.10	LiCl·C <sub>5</sub> H <sub>5</sub> N	45	15.58	18.46	
60	11.38	12.84	"	58	16.72	20.08	
80	11.71	13.27	"	72	17.12	20.66	
100	13.01	14.98	"	97	18.35	22.48	

tr. temp. about 28°.

**SOLUBILITY OF LITHIUM CHLORIDE AT 25° IN MIXTURES OF:**

Acetone and Benzene. (Marden and Dover, 1917.)				Ethyl Acetate and Benzene. (Marden and Dover, 1917.)			
Gms. Acetone per 100 Gms. Solvent.	Gms. LiCl per 100 Gms. Solvent.	Gms. Acetone per 100 Gms. Solvent.	Gms. LiCl per 100 Gms. Solvent.	Gms. Ethyl Acetate per 100 Gms. Solvent.	Gms. LiCl per 100 Gms. Solvent.	Gms. Ethyl Acetate per 100 Gms. Solvent.	Gms. LiCl per 100 Gms. Solvent.
100	2.30	40	0.088	100	1.78		
90	1.69	20	0.019	90	0.147		
80	0.966	10	0.009	80	0.028		
60	0.234	0	0	70	0.005		

**DISTRIBUTION OF LITHIUM CHLORIDE BETWEEN WATER AND AMYL  
ALCOHOL AT 30°.**  
(Dhar and Datta, 1913.)

Mols. LiCl per Liter.			Mols. LiCl per Liter.		
H <sub>2</sub> O Layer c <sub>1</sub> .	Alcohol Layer c <sub>2</sub> .	$\frac{c_1}{c_2}$	H <sub>2</sub> O Layer c <sub>1</sub> .	Alcohol Layer c <sub>2</sub> .	$\frac{c_1}{c_2}$
3.24	0.0347	93.37	2.68	0.0240	111.66
3.06	0.0325	94.15	2.58	0.0275	113.40
2.93	0.0300	97.70	2.34	0.0200	117
2.82	0.0275	102.58	1.84	0.0125	147.2
2.76	0.0250	110.40	0.65	0.0030	216.66

Freezing-point data (solubility, see footnote, p. 1) are given for the following mixtures of lithium chloride and other compounds.

Lithium Chloride + Lithium Hydroxide	(Scarpa, 1915.)
" + Magnesium Chloride	(Sandonnini, 1913, 1914.)
" + Manganese Chloride	(Sandonnini and Scarpa, 1913.)
" + Potassium Chloride	(Richards and Meldrum, 1917.)
" + " + NaCl	(Richards and Meldrum, 1917.)
" + Rubidium Chloride	(Richards & Meldrum, '17; Zemczny & Rambach, '10.)
" + Silver Chloride	(Sandonnini, 1911a, 1914.)
" + Sodium Chloride	(Zemczny and Rambach, 1910.)
" + Strontium Chloride	(Sandonnini, 1911, 1911a, 1914.)
" + Thallium Chloride	(Sandonnini, 1911, 1914.)
" + Tin Chloride (ous)	(Rack, 1914.)



# LITHIUM CHROMATE

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## LITHIUM CHROMATE $\text{Li}_2\text{CrO}_4 \cdot 2\text{H}_2\text{O}$ .

## LITHIUM BICHROMATE $\text{Li}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$ .

### SOLUBILITY IN WATER AT 30°.

(Schreinemaker — Z. physik. Chem. 55, 79, '06; at 18°, Myllus and Funk — Ber. 39, 1718, '07.)

Composition in Weight per cent:				Solid Phase.
Of Solution.	Of Residue.	Of Solution.	Of Residue.	
% $\text{CrO}_4$ .	% $\text{Li}_2\text{O}$ .	% $\text{CrO}_4$ .	% $\text{Li}_2\text{O}$ .	
0.0	7.09	...	...	$\text{LiOH} \cdot \text{H}_2\text{O}$
6.986	7.744	4.322	18.538	"
16.564	8.888	10.089	19.556	"
25.811	10.611	15.479	21.106	"
33.618	12.886	24.365	19.398	"
37.411	14.306	44.555	17.411	$\text{LiOH} \cdot \text{H}_2\text{O} + \text{Li}_2\text{CrO}_4 \cdot 2\text{H}_2\text{O}$
37.588	14.381	36.331	18.552	"
37.495	13.311	51.075	16.384	$\text{Li}_2\text{CrO}_4 \cdot 2\text{H}_2\text{O}$
40.280	10.858	...	...	"
43.404	11.809	53.793	14.070	$\text{Li}_2\text{CrO}_4 \cdot 2\text{H}_2\text{O} + \text{Li}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$
45.130	9.515	56.085	10.190	$\text{Li}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$
47.945	7.951	58.029	9.238	"
57.031	6.432	65.560	8.733	"
67.731	5.713	71.687	8.513	$\text{Li}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O} + \text{CrO}_3$
67.814	5.689	80.452	3.780	"
65.200	4.661	...	...	$\text{CrO}_3$
63.257	2.141	85.914	0.758	"
62.28	...	...	...	"

A saturated aqueous solution contains:

49.985 per cent  $\text{Li}_2\text{CrO}_4$ , or 100 grams  $\text{H}_2\text{O}$  dissolve 99.94 grams  $\text{Li}_2\text{CrO}_4$  at 30° (S.).

56.6 per cent  $\text{Li}_2\text{Cr}_2\text{O}_7$ , or 100 grams  $\text{H}_2\text{O}$  dissolve 130.4 grams  $\text{Li}_2\text{Cr}_2\text{O}_7$  at 30° (S.).

52.6 per cent  $\text{Li}_2\text{CrO}_4$ , or 100 grams  $\text{H}_2\text{O}$  dissolve 110.9 grams  $\text{Li}_2\text{CrO}_4$  at 18° (M. and F.).

Sp. Gr. of sat. solution at 18° = 1.574.

## LITHIUM CITRATE $\text{C}_3\text{H}_4(\text{OH})(\text{COOLi})_3 \cdot 4\text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 61.2 gms. Li citrate at 15°.  $d_{15}^{\text{sat. sol.}} = 1.187$ .  
(Greenish and Smith, 1902.)

### SOLUBILITY IN AQUEOUS ALCOHOL AT 25°.

(Seidell, 1910.)

Wt. % $\text{C}_2\text{H}_5\text{OH}$ in Solvent.	$d_{25}$ of Sat. Sol.	Gms. $\text{C}_3\text{H}_4(\text{OH})(\text{COOLi})_3 \cdot 4\text{H}_2\text{O}$ per 100 Gms. Solvent.	Wt. % $\text{C}_2\text{H}_5\text{OH}$ in Solvent.	$d_{25}$ of Sat. Sol.	Gms. $\text{C}_3\text{H}_4(\text{OH})(\text{COOLi})_3 \cdot 4\text{H}_2\text{O}$ per 100 Gms. Solvent.
0	1.216	74.50	50	0.933	4.93
10	1.150	49.30	60	0.897	2.25
20	1.083	32.10	70	0.867	0.60
30	1.025	18.80	80	0.838	0.30
40	0.976	9.65	100	0.788	0.02



**LITHIUM FLUORIDE** LiF.

100 gms. H<sub>2</sub>O dissolve 0.27 gm. LiF at 18°. Sp. gr. of sol. = 1.003.  
(Mylius and Funk, 1897.)  
F.-pt. data for LiF + LiOH and for LiOH + LiF are given by Scarpa, 1915.

**LITHIUM FORMATE** HCOOLi.

SOLUBILITY IN WATER.  
(Groschuff, 1903.)

t°.	Gms. HCOOLi per 100 Gms. Solution.	Mols. HCOOLi per 100 Mols. H <sub>2</sub> O.	Solid Phase.	t°.	Gms. HCOOLi per 100 Gms. Solution.	Mols. HCOOLi per 100 Mols. H <sub>2</sub> O.	Solid Phase.
-20	21.14	9.28	HCOOLi.H <sub>2</sub> O	91	54.16	40.90	HCOOLi.H <sub>2</sub> O
0	24.42	11.18	"	98	57.05	45.99	HCOOLi
18	27.85	13.36	"	104	57.64	47.11	"
49.5	35.60	19.14	"	120	59.63	51.13	"
74	44.91	28.22	"				

Sp. gr. sat. sol. at 18° = 1.142.

SOLUBILITY OF NEUTRAL LITHIUM FORMATE IN ANHYDROUS FORMIC ACID.  
(Groschuff, 1903.)

t°.	Gms. HCOOLi per 100 Gms. Solution.	Mols. HCOOLi per 100 Mols. HCOOH.	Solid Phase.
0	25.4	30	HCOOLi
18	25.9	30.9	"
39	26.4	31.75	"
60	26.9	32.6	"
79	27.8	34	"

**LITHIUM HIPPURATE** C<sub>6</sub>H<sub>5</sub>CO.NHCH<sub>2</sub>COOLi.

100 gms. H<sub>2</sub>O dissolve about 40 gms. of the salt at 15-20°.  
(Squire and Caines, 1905.)

**LITHIUM HYDROXIDE** LiOH.H<sub>2</sub>O.

SOLUBILITY IN WATER.  
(Dittmar, 1888; Pickering, 1893.)

t°.	Gms. per 100 Gms. Solution.		Gms. LiOH per 100 Gms. H <sub>2</sub> O.	t°.	Gms. per 100 Gms. Solution.		Gms. LiOH per 100 Gms. H <sub>2</sub> O.
	Li <sub>2</sub> O	= LiOH.			Li <sub>2</sub> O	= LiOH.	
-10.5	...	7.23	...	30	7.05	11.27	12.9
-18 Extec.	...	11.2	...	40	7.29	11.68	13
0	6.67	10.64	12.7	50	7.56	12.12	13.3
10	6.74	10.80	12.7	60	7.96	12.76	13.8
20	6.86	10.99	12.8	80	8.87	14.21	15.3
25	6.95	11.14	12.9	100	10.02	16.05	17.5

SOLUBILITY OF LITHIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF LITHIUM SULFOANTIMONATE AT 30° AND VICE VERSA.

(Donk, 1908.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
LiOH.	Li <sub>2</sub> SbS <sub>4</sub> .		LiOH.	Li <sub>2</sub> SbS <sub>4</sub> .	
11.4	0	LiOH.H <sub>2</sub> O	2.1	48.3	LiOH.H <sub>2</sub> O
9.1	8.3	"	2.1	52.1	" + Li <sub>2</sub> SbS <sub>4</sub> .10H <sub>2</sub> O
2.3	29.9	"	1.4	51.8	Li <sub>2</sub> SbS <sub>4</sub> .10H <sub>2</sub> O
			0	51.3	"

Data for equilibrium in the system lithium hydroxide, phenol, water at 25° are given by van Meurs, 1916.



**LITHIUM IODATE**

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**LITHIUM IODATE**  $\text{Li}(\text{IO}_3)_2 \cdot \frac{1}{2} \text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 80.3 gms.  $\text{LiIO}_3$  at  $18^\circ$ , or 100 gms. solution contain 44.6 grams. Sp. gr. of sol. = 1.568. (Mylius and Funk, 1897.)

**LITHIUM IODIDE**  $\text{LiI} \cdot 3\text{H}_2\text{O}$ .

SOLUBILITY IN WATER.  
(Kremers, 1858, 1860; ice curve, Jones, 1907.)

t°.	Gms. per 100 Gms.		Solid Phase.	t°.	Gms. per 100 Gms.		Solid Phase.
	Water.	Sat. Sol.			Water.	Sat. Sol.	
-0.296	1.08	1.06	Ice	20	165	62.2	$\text{LiI} \cdot 3\text{H}_2\text{O}$
-1.218	4.36	4.19	"	25	167	62.6	"
-2.70	8.71	8.02	"	30	171	63.1	"
-6.14	17.69	15.03	"	40	179	64.2	"
-16.2	38.31	27.70	"	50	187	65.2	"
-25	48.67	32.72	"	60	202	66.9	"
-59	85.13	46	"	70	230	69.7	"
-60 Eutec.	93	48.2	Ice + $\text{LiI} \cdot 3\text{H}_2\text{O}$	75	263	72.5	"
-60	100	50	$\text{LiI} \cdot 3\text{H}_2\text{O}$	75	m. pt.	...	"
-40	118	54.13	"	85	m. pt.	...	$\text{LiI} \cdot 2\text{H}_2\text{O}$
-20	134	57.27	"	80	435	81.3	$\text{LiI} \cdot \text{H}_2\text{O}$
0.	151	60.2	"	100	481	82.8	"
10	157	61.1	"	120	590	85.5	"

## SOLUBILITY OF LITHIUM IODIDE IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. LiI per 100 Gms. Solvent.	Authority.
Methyl Alcohol	25	343.4	(Turner and Bissett, 1913.)
Ethyl Alcohol	25	250.8	" "
Propyl Alcohol	25	47.52*	" "
Amyl Alcohol	25	112.5	" "
Glycol	15.3	38.9	(de Coninck, 1905.)
Furfural	25	45.9†	(Walden, 1906.)
Nitromethane	0	1.22†	"
"	25	2.52	"

\* Solid phase =  $\text{LiI} \cdot \text{C}_2\text{H}_5\text{OH}$ .

† = gms. per 100 cc. sat. solution.

F.-pt. data for  $\text{LiI} + \text{AgI}$  are given by Sandonnini and Scarpa, 1913.**LITHIUM IODOMERCURATE**  $2\text{LiI} \cdot \text{HgI}_2 \cdot 6\text{H}_2\text{O}$ .

100 gms. sat. solution of lithium iodomercurate in water prepared by cooling a hot solution and allowing to stand at  $24.7^\circ$  for 3 months, contained 1.30 gms. Li, 27.4 gms. Hg, 58 gms. I and 13.3 gms.  $\text{H}_2\text{O}$ ; Sp. Gr. of the sat. sol. = 3.28. (Duboin, 1905.)

**LITHIUM LAURATE, MYRISTATE**, etc.

SOLUBILITY IN WATER AND IN ALCOHOL OF  $d = 0.797$ , AT  $18^\circ$  AND AT  $25^\circ$ .  
(Partheil and Feric, 1903.)

Salt.	Formula.	Gms. Salt per 100 cc. Sat. Solution in:			
		Water at		Alcohol at	
		18°.	25°.	18°.	25°.
Stearate	$\text{C}_{17}\text{H}_{35}\text{COOLi}$	0.010	0.011	0.041	0.0532
Palmitate	$\text{C}_{16}\text{H}_{31}\text{COOLi}$	0.011	0.018	0.0796	0.0956
Myristate	$\text{C}_{14}\text{H}_{27}\text{COOLi}$	0.0232	0.0234	0.184	0.2100
Laurate	$\text{C}_{12}\text{H}_{23}\text{COOLi}$	0.158	0.1726	0.418	0.4424
Oleate	$\text{C}_{17}\text{H}_{33}\text{COOLi}$	0.0674	0.1320	0.9084	1.010



**LITHIUM LAURATE, MYRISTATE, PALMITATE and STEARATE.**

SOLUBILITY OF EACH OF THESE SALTS, DETERMINED SEPARATELY, IN  
SEVERAL SOLVENTS.

(Jacobson and Holmes, 1916.)

Laurate =  $C_{11}H_{23}COOLi$ . Li myristate =  $C_{13}H_{27}COOLi$ , Li palmitate =  $C_{15}H_{31}COOLi$  and Li stearate =  $C_{17}H_{35}COOLi$ .

1 g. of salt shaken with solvent for 2 hrs. in all cases. The sat. sol. was obtained by evaporating to dryness and weighing residue.

Solvent.	t°.	Gms. of Each Salt (determined separately) per 100 Gms. Solvent.			
		Li Laurate.	Li Myristate.	Li Palmitate.	Li Stearate.
Ethyl Alcohol	20	0.403	0.194	0.096	0.072
" "	25.4	0.447	0.224	0.118	0.089
" "	35	0.546	0.278	0.142	0.106
" "	50	0.782	0.435	0.248	0.200
" "	65	1.149	0.669	0.391	0.333
1 Alcohol	15.2	3.159	1.346	0.616	0.349
" "	25	3.773	1.680	0.771	0.439
" "	34.6	4.597	2.193	1.086	0.658
" "	50	6.088	3.281	1.652	1.057
" "	16.3	0.154	0.027	0.010	0.009
" "	25	0.187	0.036	0.015	0.010
" "	35	0.207	0.042	0.015	0.010
" "	50	0.280	0.062	...	...
" "	15.8	0.011	0.013	0.007	0.011
" "	25	0.006	0.004	0.007	0.011
Alcohol	16	0.073	0.029	0.019	0.011
" "	25.7	0.111	0.046	0.032	0.028
" "	35	0.126	0.062	0.033	0.031
" "	49.2	0.203	0.109	0.069	0.060
Form	15.2	0.006	0.004	0.004	0.004
Acetate	14.5	0.068	0.037	0.038	0.034
" "	25	0.064	0.034	0.024	0.029
" "	35	0.061	0.044	0.037	0.031
" "	50	0.061	0.045	0.036	0.044
yl Acetate	24.5	0.026	0.013	0.015	0.012
one	15	0.300	0.413	0.434	0.571
" "	25	0.376	0.447	0.508	0.706
" "	35	0.430	0.502	0.537	0.663

The above lithium salts were prepared by adding the calculated amount of lithium acetate to the alcoholic solutions of the respective fatty acids. The resulting precipitates were dissolved in boiling alcohol and the solutions allowed to stand over night in a cool place. The salts so obtained were washed and dried.

**LITHIUM TetramOLYBDATE**  $Li_2O.MoO_3.2H_2O$ .

A cc. sat. aqueous solution contain 43.13 gms.  $Li_2O.MoO_3.2H_2O$  at 20°.  $d_{20}$  = 1.44. (Wempe, 1912.)



LITHIUM NITRATE  $\text{LiNO}_3 \cdot 3\text{H}_2\text{O}$ .

SOLUBILITY IN WATER. (Donnan and Burt, 1903.)

t°.	Gms. $\text{LiNO}_3$ per 100 Gms. Solution.	Solid Phase.	t°.	Gms. $\text{LiNO}_3$ per 100 Gms. Solution.	Solid Phase.
0.1	34.8	$\text{LiNO}_3 \cdot 3\text{H}_2\text{O}$	29.87	56.42	$\text{LiNO}_3 \cdot 3\text{H}_2\text{O}$
10.5	37.9	"	29.86	56.68	"
12.1	38.2	"	29.64	57.48	"
13.75	39.3	"	29.55	58.05	"
19.05	40.4	"	43.6	60.8	$\text{LiNO}_3 \cdot 4\text{H}_2\text{O}$
22.1	42.9	"	50.5	61.3	"
27.55	47.3	"	55	63	"
29.47	53.67	"	60	63.6	"
29.78	55.09	"	64.2	64.9	$\text{LiNO}_3$
			70.9	66.1	"

The eutectic Ice +  $\text{LiNO}_3 \cdot 3\text{H}_2\text{O}$ , is at  $-17.8^\circ$  and about 33 gms.  $\text{LiNO}_3$  per 100 gms. sat. sol. Transition points,  $29.6^\circ$  and  $61.1^\circ$ .

Data for the system  $\text{LiNO}_3 + \text{Li}_2\text{SO}_4 + \text{H}_2\text{O}$  at  $0^\circ$ ,  $30^\circ$  and  $70^\circ$  are given by Massink, 1916.

A sat. solution of lithium nitrate in acetone contains 0.343 gm. mols. = 23.67 gms. per liter at about  $20^\circ$ . (Roohdestwensky and Lewis, 1911)

Freezing-point data for  $\text{LiNO}_3 + \text{KNO}_3$  and  $\text{LiNO}_3 + \text{NaNO}_3$  are given by Carveth, 1898. Results for  $\text{LiNO}_3 + \text{KNO}_3$  are also given by Harkins and Clark, 1915.

Results for  $\text{LiNO}_3 + \text{Li}_2\text{SO}_4$  are given by Amadori, 1913.

LITHIUM NITRITE  $\text{LiNO}_2 \cdot \text{H}_2\text{O}$ .

SOLUBILITY IN WATER. (Oswald, 1914.)

t°.	Gms. $\text{LiNO}_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{LiNO}_2$ per 100 Gms. Sat. Sol.	Solid Phase.
-7.5	11.1	Ice	38.5	55.5	$\text{LiNO}_2 \cdot \text{H}_2\text{O}$
-11.7	15	"	42	56.9	"
-21	21.2	"	49	60.6	"
-28.8	29	"	49.5	61.2	" + $\text{LiNO}_2 \cdot \text{H}_2\text{O}$
-31.3	29.4	" + $\text{LiNO}_2 \cdot \text{H}_2\text{O}$	65	63.8	$\text{LiNO}_2 \cdot 1\frac{1}{2}\text{H}_2\text{O}$
-19.3	33.9	$\text{LiNO}_2 \cdot \text{H}_2\text{O}$	81.5	68.7	"
0	41.5	"	91	72.4	"
+19	48.9 ( $d_{15}=1.3186$ )	"	96	91.8	"
25	50.9	"	92.5	94.3	"

100 gms.  $\text{H}_2\text{O}$  dissolve 10.5 gms.  $\text{AgNO}_3$  + 78.5 gms.  $\text{LiNO}_2$  at  $14^\circ$ . (Oswald,

LITHIUM OXALATE  $\text{Li}_2\text{C}_2\text{O}_4$ .

SOLUBILITY OF MIXTURES OF LITHIUM OXALATE AND OXALIC ACID IN WATER AT  $25^\circ$ . (Foote and Andrew, 1905.)

Mixtures of the two substances were dissolved in water, and the solutions cooled in a thermostat to  $25^\circ$ .

Gms. per 100 Gms. Solution.		Mols. per 100 Mols. $\text{H}_2\text{O}$ .		Solid Phase.
$\text{H}_2\text{C}_2\text{O}_4$ .	$\text{Li}_2\text{C}_2\text{O}_4$ .	$\text{H}_2\text{C}_2\text{O}_4$ .	$\text{Li}_2\text{C}_2\text{O}_4$ .	
10.20	...	2.274	...	$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$
10.66	2.96	2.457	0.622	$\text{H}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$ and $\text{HLiC}_2\text{O}_4 \cdot \text{F}$
10.55	3.11			
8.08	3.18	1.823	0.633	Double Salt $\text{HLiC}_2\text{O}_4 \cdot 4\text{H}_2\text{O}$ = $39.2\text{H}_2\text{C}_2\text{O}_4$ and $44.7\text{Li}_2\text{C}_2\text{O}_4$
2.60	5.03	0.563	0.962	
2.16	6.54	0.469	1.273	$\text{HLiC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ and $\text{Li}_2\text{C}_2\text{O}_4$
2.12	1.61			
	5.87	...	1.901	$\text{Li}_2\text{C}_2\text{O}_4$

100 gms. aqueous solution, simultaneously saturated with lithium oxalate and ammonium oxalate at  $25^\circ$ , contain 5.75 gms.  $\text{Li}_2\text{C}_2\text{O}_4$  + 4.8 gms.  $(\text{NH}_4)_2\text{C}_2\text{O}_4$ . (Foote and Andrew, 1905.)



**LITHIUM PHOSPHATE**  $\text{Li}_3\text{PO}_4$ .800 gms.  $\text{H}_2\text{O}$  dissolve 0.04 gm.  $\text{Li}_3\text{PO}_4$ .

(Mayer, 1856.)

**LITHIUM (Hypo) PHOSPHATE**  $\text{Li}_4\text{P}_2\text{O}_6 \cdot 7\text{H}_2\text{O}$ .100 gms.  $\text{H}_2\text{O}$  dissolve 0.83 gm. hypophosphate at ord. temp. (Rammelsberg, 1892.)**LITHIUM PERMANGANATE**  $\text{LiMnO}_4 \cdot 3\text{H}_2\text{O}$ 100 gms. water dissolve 71.4 gms. permanganate at  $16^\circ$ .

(Ashoff.)

**LITHIUM SALICYLATE**  $\text{C}_6\text{H}_4\text{OHCOOLi} \cdot \frac{1}{2}\text{H}_2\text{O}$ .SOLUBILITY IN AQUEOUS ALCOHOL SOLUTIONS AT  $25^\circ$ .

(Seidell, 1909, 1910.)

Gms. $\text{C}_6\text{H}_5\text{OH}$ per 100 Gms. Solvent.	$d_m$ of Sat. Sol.	Gms. $\text{C}_6\text{H}_4\text{OHCOOH} \cdot \frac{1}{2}\text{H}_2\text{O}$ per 100 Gms. Sat. Sol.	Gms. $\text{C}_6\text{H}_5\text{OH}$ per 100 Gms. Solvent.	$d_m$ of Sat. Sol.	Gms. $\text{C}_6\text{H}_4\text{OHCOOH} \cdot \frac{1}{2}\text{H}_2\text{O}$ per 100 Gms. Sat. Sol.
0	1.209	56	60	1.104	51.1
10	1.195	55.9	70	1.083	49.5
20	1.180	55.4	80	1.056	47.5
30	1.163	54.7	90	1.026	45.8
40	1.144	53.7	92.3	1.020	45.6
50	1.124	52.5	100	1.027	48.2

100 gms. propyl alcohol dissolve 18.7 gms. Li salicylate (temp.?). (Schlamp, 1895.)

**LITHIUM SULFATE**  $\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Average curve from Kremers, 1855; Etard, 1894.)

t°.	Gms. $\text{Li}_2\text{SO}_4$ per 100 Gms. Solution.	t°.	Gms. $\text{Li}_2\text{SO}_4$ per 100 Gms. Solution.	t°.	Gms. $\text{Li}_2\text{SO}_4$ per 100 Gms. Solution.
-20	18.4	20	25.5	50	24.5
-10	24.2	25	25.3	60	24.2
0	26.1	30	25.1	80	23.5
10	25.9	40	24.7	100	23

## SOLUBILITY OF LITHIUM-POTASSIUM SULFATE IN WATER.

(Spielrein, 1913.)

t°.	Gms. per 100 cc. Sat. Sol.	Solid Phase.	t°.	Gms. per 100 cc. Sat. Sol.	Solid Phase.
	$\text{Li}_2\text{SO}_4$ $\text{K}_2\text{SO}_4$			$\text{Li}_2\text{SO}_4$ $\text{K}_2\text{SO}_4$	
20	35 - 6	$\text{Li}_2\text{SO}_4 \cdot \text{K}_2\text{SO}_4 + \text{Li}_2\text{SO}_4$	60	10.6 16.3	$\text{Li}_2\text{SO}_4 \cdot \text{K}_2\text{SO}_4 + \text{K}_2\text{SO}_4$
30	13 - 3	" + $\text{K}_2\text{SO}_4$	98	30.2 9.3	" + $\text{Li}_2\text{SO}_4$
60	32 - 5	" + $\text{Li}_2\text{SO}_4$	98	9 23	" + $\text{K}_2\text{SO}_4$

## SOLUBILITY OF LITHIUM-SODIUM SULFATES IN WATER.

(Spielrein, 1913.)

t°.	Gms. per 100 cc. Sat. Sol.	Solid Phase.	t°.	Gms. per 100 cc. Sat. Sol.	Solid Phase.
	$\text{Li}_2\text{SO}_4$ $\text{Na}_2\text{SO}_4$			$\text{Li}_2\text{SO}_4$ $\text{Na}_2\text{SO}_4$	
0	31 - 4	$\text{Li}_2\text{SO}_4 \cdot \text{Na}_2\text{SO}_4 \cdot \frac{1}{2}\text{H}_2\text{O} + \text{Li}_2\text{SO}_4$	33.5	25.8 13.9	$\text{Li}_2\text{SO}_4 \cdot \text{Na}_2\text{SO}_4 \cdot \frac{1}{2}\text{H}_2\text{O} + \text{Li}_2\text{SO}_4$
0	18.5	" + $\text{Na}_2\text{SO}_4$	33.5	13.9 21.8	" + $\text{Na}_2\text{SO}_4$
1.5	20.4	" (triple pt.)	53	28 16.6	" + $\text{Li}_2\text{SO}_4$
16	32	"	53	16.7 27.3	" + $\text{Na}_2\text{SO}_4$
24	26	$\text{Li}_2\text{SO}_4 \cdot \text{Na}_2\text{SO}_4 \cdot \frac{1}{2}\text{H}_2\text{O} + \text{Li}_2\text{SO}_4$	99	27.4 14.4	" + $\text{Li}_2\text{SO}_4$
24	16.5	" + $\text{Na}_2\text{SO}_4$	99	14.4 25.1	" + $\text{Na}_2\text{SO}_4$
25	20	" (triple pt.)			

There is some uncertainty as to whether all of the above results are in terms of grams per 100 cc. or per 100 gms. of sat. solution.

## SOLUBILITY OF LITHIUM SULFATE IN ABSOLUTE SULFURIC ACID.

(Bergius, 1910.)

10 cc. sat. solution in abs.  $\text{H}_2\text{SO}_4$  contain 2.719 gms.  $\text{Li}_2\text{SO}_4$  and the crystalline solid phase has the composition  $\text{Li}_2\text{SO}_4 \cdot 7\text{H}_2\text{SO}_4$  and melts at about  $12^\circ$ .



SOLUBILITY OF LITHIUM SULFATE IN Aq.  $\text{H}_2\text{SO}_4$  AT  $30^\circ$ . (van Dorp, 1932.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{H}_2\text{SO}_4$ .	$\text{Li}_2\text{SO}_4$ .		$\text{H}_2\text{SO}_4$ .	$\text{Li}_2\text{SO}_4$ .	
5.05	22.74	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$	55.08	13.69	$\text{Li}_2\text{SO}_4$
12.23	20.45	"	61.46	17.10	"
16.60	19.10	"	62.49	18.89	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
32.70	13.37	"	69.40	13.75	"
42.98	10.57	"	78.23	11.64	"
52.72	11.44	"	83.43	15.65	"

SOLUBILITY OF LITHIUM SULFATE IN AQUEOUS ALCOHOL AT  $30^\circ$ .

(Schreinemakers and van Dorp, Jr., 1906.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{C}_2\text{H}_5\text{OH}$ .	$\text{Li}_2\text{SO}_4$ .		$\text{C}_2\text{H}_5\text{OH}$ .	$\text{Li}_2\text{SO}_4$ .	
0	25.1	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$	47.28	3.04	$\text{Li}_2\text{SO}_4 \cdot \text{H}_2\text{O}$
11.75	16.16	"	58.59	1.22	"
21.19	11.52	"	69.39	0.396	"
29.40	8.17	"	80.74	0	"
33.31	6.66	"	94.11	0	"

F.-pt. data for  $\text{Li}_2\text{SO}_4 + \text{MnSO}_4$  are given by Calcagni and Marotta, 1911. Results for  $\text{Li}_2\text{SO}_4 + \text{SrSO}_4$  are given by Calcagni and Marotta, 1912. Results for  $\text{Li}_2\text{SO}_4 + \text{Na}_2\text{SO}_4$  and  $\text{Li}_2\text{SO}_4 + \text{K}_2\text{SO}_4$  are given by Nacken, 1907; results for  $\text{Li}_2\text{SO}_4 + \text{Ag}_2\text{SO}_4$  are given by Nacken, 1907b.

LITHIUM SILICATE  $\text{Li}_2\text{SiO}_3$ .

Fusion point data for  $\text{Li}_2\text{O} + \text{SiO}_2$  and  $\text{Li}_2\text{SiO}_3 + \text{ZnSiO}_3$  are given by Klooster, 1910-11. Results for  $\text{Li}_2\text{SiO}_3 + \text{MgSiO}_3$ ,  $\text{Li}_2\text{SiO}_3 + \text{Na}_2\text{SiO}_3$ ,  $\text{Li}_2\text{SiO}_3 + \text{K}_2\text{SiO}_3$  and  $\text{Li}_2\text{SiO}_3 + \text{SrSiO}_3$  are given by Wallace, 1909.

## LITHIUM TARTRATES.

## SOLUBILITY IN WATER.

Salt.	Formula.	t°.	Gms. Salt per 100 Gms. Sat. Sol.	Author.
Lithium Dihydroxytartrate	$\text{Li}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 2\frac{1}{2}\text{H}_2\text{O}$	0	0.079	(Fenton, 1883)
Lithium Sodium Racemic Tartrate	$\text{LiNaC}_4\text{H}_4\text{O}_6 \cdot 2\text{H}_2\text{O}$	20	19.97	(Schlosser, 1883)
" " Dextro "	"	20	22.55	"
" Potassium Racemic "	$\text{LiKC}_4\text{H}_4\text{O}_6 \cdot \text{H}_2\text{O}$	20	55.19	"
" " Dextro "	"	20	37.82	"

MAGNESIUM Mg. F.-pt. data for  $\text{Mg} + \text{Hg}$ .

(Cambi and Sperling, 1907.)

MAGNESIUM ACETATE  $\text{Mg}(\text{CH}_3\text{COO})_2 \cdot 4\text{H}_2\text{O}$ .

## EQUILIBRIUM IN THE SYSTEM MAGNESIUM OXIDE-ACETIC ACID-WATER

(Iwaki, 1914.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{CH}_3\text{COOH}$ .	$\text{MgO}$ .		$\text{CH}_3\text{COOH}$ .	$\text{MgO}$ .	
3.36	1.73	$\text{MgO}$	31.37	7.99	$(\text{CH}_3\text{COO})_2\text{Mg} \cdot 4\text{H}_2\text{O}$
5.65	2.93	"	36.23	8.18	"
8.06	4.21	"	35.77	8.17	2.3.3
12.46	6.54	"	40.87	7.42	"
15.46	8.24	" $+ (\text{CH}_3\text{COO})_2\text{Mg} \cdot 4\text{H}_2\text{O}$	47.86	6.74	"
15.38	8.31	$(\text{CH}_3\text{COO})_2\text{Mg} \cdot 4\text{H}_2\text{O}$	56.16	5.81	"
14.25	7.24	"	61.59	4.68	"
20.19	7.47	"	69.13	3.75	"
22.93	7.60	"	75.93	2.85	"
26.61	7.74	"	82.90	2.23	"

2.3.3 =  $2(\text{CH}_3\text{COO})_2\text{Mg} \cdot 3\text{CH}_3\text{COOH} \cdot 3\text{H}_2\text{O}$ . More careful work in the region of the double salt showed that a second double salt of the composition  $5(\text{CH}_3\text{COO})_2\text{Mg} \cdot 10\text{CH}_3\text{COOH} \cdot 7\text{H}_2\text{O}$  was obtained. This compound usually separated from the more concentrated acetic acid solutions.



**MAGNESIUM BENZOATE**  $\text{Mg}(\text{C}_6\text{H}_5\text{COO})_2 \cdot 4\text{H}_2\text{O}$ .

$\text{H}_2\text{O}$  dissolve 6.16 gms.  $\text{Mg}(\text{C}_6\text{H}_5\text{COO})_2$  at  $15^\circ$  and 19.6 gms. at  $100^\circ$ .  
(Tarugi and Checchi, 1901.)

$\text{H}_2\text{O}$  dissolve 3.33 gms.  $\text{Mg}(\text{C}_6\text{H}_5\text{COO})_2$  at  $15-20^\circ$ . (Squire and Caines, 1905.)

**MAGNESIUM BROMATE**  $\text{Mg}(\text{BrO}_3)_2 \cdot 6\text{H}_2\text{O}$ .

sat. solution contain 42 grams  $\text{Mg}(\text{BrO}_3)_2$ , or 0.15 gram mols.

(Kohlrausch — Sitzb. K. Akad. Wiss. (Berlin), 1, 90, '97.)

**MAGNESIUM BROMIDE**  $\text{MgBr}_2 \cdot 6\text{H}_2\text{O}$ .

#### SOLUBILITY IN WATER.

kin — Chem. Centr. 77, I, 646, '06; at  $18^\circ$ , Mylius and Funk — Ber. 30, 1718, '97.)

Grams $\text{MgBr}_2$ per 100 Gms.		$t^\circ$	Grams $\text{MgBr}_2$ per 100 Grams.	
Solution.	Water.		Solution.	Water.
47.2	89.4	40	50.4	101.6
47.9	91.9	50	51.0	104.1
48.6	94.5	60	51.8	107.5
49.0	96.1	80	53.2	113.7
50.8	103.4 (M. and F.)	100	54.6	120.2
49.1	96.5	120	56.0	127.5
49.4	97.6	140	58.0	138.1
49.8	99.2	160	62.0	163.1

of saturated solution at  $18^\circ$  = 1.655 (M. and F.)

— Ann. chim. phys. [7] 2, 541, '94, gives solubility results evidently too high.

#### MAGNESIUM BROMIDE ETHERATES, ALCOHOLATES, ACIDATES,

SOLUBILITIES RESPECTIVELY IN ETHER, ALCOHOL, ACIDS, ETC., AT  
VARIOUS TEMPERATURES.

schutkin. Monograph in the Russian language entitled "On Etherates and Other Moleculations of Magnesium Bromide and Iodide." St. Petersburg, 1907, pp. 267 and XLVIII. Included in the Memoirs of the St. Petersburg Polytechnic Institute, Vols. 1-7, 1904-1907, and also in Vols. 49-62 of the Zeit. anorg. Chem., 1906-1909.)

**Preparation of Material.** The dietherate of magnesium bromide,  $\text{H}_2\text{O}$  (Z. anorg. Chem., 49, 34, '06) was prepared by the very gradual addition of bromine to a cold mixture of magnesium powder and dry ether. The product is hygroscopic and is stable only under its ethereal solution. It is decomposed by water and reacts with very many organic compounds as alcohols, acids, esters, aldehydes, etc. The addition products thus formed were the material employed in the author's succeeding studies. The monomagnesium bromide,  $\text{MgBr}_2 \cdot (\text{C}_2\text{H}_5)_2\text{O}$ , was prepared just as the dietherate but the temperature during crystallization was kept above  $30^\circ$ , at which the dietherate is converted to monoetherate. It is also precipitated from its ethereal solution by addition of water.

**Method of Determination of Solubility.** At temperatures below  $30^\circ$  the solubility was determined by agitating an excess of the salt with the solvent and filtering the saturated solution. At the higher temperatures the synthetic method of Alexejeff (Wied. Ann., 1885) was used.



# MAGNESIUM BROMIDE ETHERATES

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SOLUBILITY OF MAGNESIUM BROMIDE DIETHERATE,  $\text{MgBr}_2 \cdot 2(\text{C}_2\text{H}_5)_2\text{O}$ , AND OF  
MAGNESIUM BROMIDE ETHERATE,  $\text{MgBr}_2(\text{C}_2\text{H}_5)_2\text{O}$ , IN ETHYL ETHER,  $(\text{C}_2\text{H}_5)_2\text{O}$ ,  
AT VARIOUS TEMPERATURES.

(Menschutkin. See preceding page.)

Solubility of the Dietherate in Ether.				Solubility of the Monoetherate in Ether.			
t°.	Gms. per 100 Gms. Sat. Sol. $\text{MgBr}_2 \cdot 2(\text{C}_2\text{H}_5)_2\text{O}$	Gms. Sat. Sol. $\text{MgBr}_2$	Mols. $\text{MgBr}_2 \cdot 2(\text{C}_2\text{H}_5)_2\text{O}$ per 100 Mols. Sat. Sol.	t°.	Gms. per 100 Gms. Sat. Sol. $\text{MgBr}_2(\text{C}_2\text{H}_5)_2\text{O}$	Gms. Sat. Sol. $\text{MgBr}_2$	Mols. $\text{MgBr}_2(\text{C}_2\text{H}_5)_2\text{O}$ per 100 Mols. Sat. Sol.
- 8	1.08	0.6	0.24	0	68.8	49.1	28.1
0	1.44	0.8	0.32	20	67.2	47.9	27.1
+10	2.3	1.27	0.52	30	66.5	47.3	26.6
14	2.95	1.64	0.67	40	65.5	46.7	26.1
16	3.48	1.93	0.80	60	63.8	45.5	25.1
18	4.14	2.3	0.96	80	62.1	44.3	24.2
20	4.86	2.7	1.125	100	60.7	43.3	23.5
22.8	6.3	3.5	1.6	120	59.6	42.5	22.9
Two liquid layers separate between these concentrations of $\text{MgBr}_2 \cdot 2(\text{C}_2\text{H}_5)_2\text{O}$ .				140	58.5	41.7	22.3
23	72.3	40.1	36.8	158	57.5	41	21.9
24	75.3	41.8	40.5	Two liquid layers separate between these concentrations of $\text{MgBr}_2(\text{C}_2\text{H}_5)_2\text{O}$ .			
26	79.5	44.1	46.6	158	5.8	4.15	1.6
28.5	84.2	46.7	54.2	158	4.8	3.4	1.36
30	85.5	47.4	56.9	159	1.96	1.4	0.56
				162	0.38	0.27	0.11
				170	0.18	0.13	0.05

At 22.8° and 158° the saturated solutions of the dietherate and monoetherate respectively, separate into two liquid layers which have at the intervening temperatures the following composition. Determinations of the specific gravity the lower layer gave  $d_{44}^{25} = 1.1628$  and  $d_{44}^{25} = 1.1492$ .

t°.	Gms. per 100 Gms. Solution.				
	Lower Layer.		Upper Layer.		
	MgBr <sub>2</sub> .2(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	MgBr <sub>2</sub> .	MgBr <sub>2</sub> .2(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	MgBr <sub>2</sub> .	
-10	75.75	42	3.2	1.8	unstable
0	73.9	41	4.1	2.3	"
+10	72.2	40.1	5	2.8	"
20	70.8	39.3	5.9	3.3	stable
30	69.8	38.7	6.8	3.8	
40	68.8	38.2	7.7	4.3	
50	68	37.8	8.5	4.7	
60	67.7	37.6	9.2	5.1	
70	67.7	37.6	9.7	5.4	
80	68	37.8	10	5.6	
90	68.6	38.1	10.2	5.7	
100	69.4	38.5	10.4	5.8	
120	71	39.3	10.1	5.6	
140	72.4	40.15	9.2	5.1	
158	74	41	7.8	4.3	



# MAGNESIUM BROMIDE ALCOHOLATES

SOLUBILITY OF ETHYL, METHYL, PROPYL, ETC., ALCOHOLATES OF MAGNESIUM BROMIDE IN THE RESPECTIVE ALCOHOLS. (Menschutkin, 1907.)

These compounds were all prepared by the action of magnesium bromide upon the several alcohols. The ether was expelled and the new alcohol addition product recrystallized from the respective alcohol. The solubility determinations were made by the synthetic method.

Solubility of $\text{MgBr}_2 \cdot 6\text{C}_2\text{H}_5\text{OH}$ in Ethyl Alcohol.	Solubility of $\text{MgBr}_2 \cdot 6\text{C}_2\text{H}_5\text{OH}$ in Ethyl Alcohol.	Solubility of $\text{MgBr}_2 \cdot 6\text{C}_2\text{H}_5\text{OH}$ in Propyl Alcohol.	Solubility of $\text{MgBr}_2 \cdot 6\text{C}_2\text{H}_5\text{OH}$ in Iso Butyl Alcohol.				
Gms. $\text{MgBr}_2 \cdot 6\text{C}_2\text{H}_5\text{OH}$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{MgBr}_2 \cdot 6\text{C}_2\text{H}_5\text{OH}$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{MgBr}_2 \cdot 6\text{C}_2\text{H}_5\text{OH}$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{MgBr}_2 \cdot 6\text{C}_2\text{H}_5\text{OH}$ per 100 Gms. Sat. Sol.	t°.
42.6	0	17.2	0	77.9	0	55.8	
44.6	10	24.9	10	81.5	10	60.5	
46.7	20	32.7	20	85.1	20	65.2	
48.9	30	40.3	30	88.5	30	69.8	
51.4	40	47.8	40	92	40	74.3	
55.5	60	62.2	43	93	50	78.5	
60.7	80	73.8	46	94.3	60	82.4	
66.8	90	78.7	48	95.8	65	84.2	
74	100	86.7	50	97.8	71	88	
84.5	103	90	52 m. pt.	100	75	92	
88	106	94.4			77	94.6	
-pt. 100	108.5 m. pt.	100			80 m. pt.	100	

Solubility of 1.6 Iso C <sub>8</sub> H <sub>18</sub> OH αAmyl Alcohol.	Solubility of MgBr <sub>2</sub> ·4(CH <sub>3</sub> ) <sub>2</sub> CHOH in Dimethyl Carbinol.	Solubility of MgBr <sub>2</sub> ·4(CH <sub>3</sub> ) <sub>2</sub> COH in Trimethyl Carbinol.
Gms. MgBr <sub>2</sub> · 6C <sub>8</sub> H <sub>18</sub> OH per 100 Gms. Sat. Sol.	t°.	Gms. MgBr <sub>2</sub> · 4(CH <sub>3</sub> ) <sub>2</sub> COH per 100 Gms. Sat. Sol.
70.2	0	24.7 m. pt. of (CH <sub>3</sub> ) <sub>3</sub> COH
75.6	20	24.4 Eutec.
80.2	40	0.06
84.5	60	1
86.7	80	35
88.7	100	45
90	120	19.1
92	130	55
94.2	136	32.2
	138	60
	139 m. pt.	70
	100	62.5
		75
		77
		79
		91.5
		80 m. pt.
		100

## MAGNESIUM BROMIDE ANILINATES.

SOLUBILITY OF MAGNESIUM BROMIDE ANILINATES IN ANILINE AT DIFFERENT TEMPERATURES. (Menschutkin, 1907.)

These compounds were formed by the action of aniline on magnesium bromide. The three compounds were:  $\text{MgBr}_2 \cdot 6\text{C}_6\text{H}_5\text{NH}_2$ ,  $\text{MgBr}_2 \cdot 4\text{C}_6\text{H}_5\text{NH}_2$ ,  $\text{MgBr}_2 \cdot 2\text{C}_6\text{H}_5\text{NH}_2$ .

Gms. $\text{MgBr}_2 \cdot 4\text{C}_6\text{H}_5\text{NH}_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{MgBr}_2 \cdot 4\text{C}_6\text{H}_5\text{NH}_2$ per 100 Gms. Sat. Sol.	Solid Phase.
3.2	$\text{MgBr}_2 \cdot 6\text{C}_6\text{H}_5\text{NH}_2$	160	26	$\text{MgBr}_2 \cdot 4\text{C}_6\text{H}_5\text{NH}_2$
5.1	"	180	28.3	"
7.5	"	200	33.5	"
12.8	"	220	45	"
18.5	"	230	55	"
27.5	"	237 tr. pt.	76.3	"
5 tr. pt.	$\text{MgBr}_2 \cdot 4\text{C}_6\text{H}_5\text{NH}_2$	250	77.3	$\text{MgBr}_2 \cdot 2\text{C}_6\text{H}_5\text{NH}_2$
24.3	"	260	78.1	"
24.3	"	270	79	"



## MAGNESIUM BROMIDE PHENYLHYDRAZINATES.

SOLUBILITY OF MAGNESIUM BROMIDE. PHENYLHYDRAZINATES IN 1  
HYDRAZINE.

(Menschutkin, 1907.)

(Approximate determinations.)

t°.	Gms. MgBr <sub>2</sub> . 6C <sub>6</sub> H <sub>5</sub> NHNH <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. MgBr <sub>2</sub> . 6C <sub>6</sub> H <sub>5</sub> NHNH <sub>2</sub> per 100 Gms. Sat. Sol.	Sol.
20	3	MgBr <sub>2</sub> .6C <sub>6</sub> H <sub>5</sub> NHNH <sub>2</sub>	100 tr. pt.	54.8	MgBr <sub>2</sub>
40	7	"	140	60.8	
60	16.4	"	180	68.4	
80	33	"	200	73.4	
99	54.8	"			

## MAGNESIUM BROMIDE COMPOUNDS with Benzaldehyde and wi

SOLUBILITY RESPECTIVELY IN BENZALDEHYDE AND IN ACETONE

(Menschutkin, 1907.)

The compounds were prepared by the action of benzaldehyde and of magnesium bromide dietherate. On account of the nature of the com results are only approximately correct.

Solubility of MgBr<sub>2</sub>.3C<sub>6</sub>H<sub>5</sub>COH  
in Benzaldehyde.Solubility of MgBr<sub>2</sub>.3CH<sub>3</sub>.CO.CH<sub>3</sub>  
in Acetone.

t°.	Gms. MgBr <sub>2</sub> . 3C <sub>6</sub> H <sub>5</sub> COH per 100 Gms. Sat. Sol.	t°.	Gms. MgBr <sub>2</sub> . 3C <sub>6</sub> H <sub>5</sub> COH per 100 Gms. Sat. Sol.	t°.	Gms. MgBr <sub>2</sub> . 3CH <sub>3</sub> .CO.CH <sub>3</sub> per 100 Gms. Sat. Sol.	t°.
0	0.7	140	17.8	0	0.2	75
30	1.3	145	37.5	30	0.8	76
60	1.9	146	65	60	1.45	80
100	3.4	148	84.5	70	2	84
120	6	153	93.2	73	5.5	88
130	9.5	159 m. pt.	100	74	14	92 m. p

MAGNESIUM BROMIDE COMPOUNDS with Methylal, Ortho Et  
Formic Acid and Acetic Acid.

(Menschutkin, 1907a.)

The compounds were prepared by the action of methylal, ortho et and absolutely dry formic and acetic acids on magnesium dietherate. of the latter compounds the results are only approximately correct, extreme hygroscopicity.

Solubility of MgBr<sub>2</sub>.2CH<sub>3</sub>(OCH<sub>3</sub>)<sub>2</sub> in Methylal. Solubility of MgBr<sub>2</sub>.2CH(OC<sub>2</sub>H<sub>5</sub>)<sub>2</sub> in Orthoethylformate. Solubility of MgBr<sub>2</sub>.6HCOOH in Formic Acid. Solu MgBr<sub>2</sub>.6 in Ac

t°.	Gms. MgBr <sub>2</sub> . 2CH <sub>3</sub> (OCH <sub>3</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	t°.	Gms. MgBr <sub>2</sub> . 2CH(OC <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	t°.	Gms. MgBr <sub>2</sub> . 6HCOOH per 100 Gms. Sat. Sol.	t°.
20	0.3	0	11.1	0	49.8	17
40	0.45	20	12.5	20	57.5	30
60	0.6	40	14.8	40	65.1	50
80	0.75	60	18.6	60	73.1	60
100	0.9	80	25.7	70	78.1	70
106	1.1	90	35	80	86	80
2 liquid layers here		95	41	86	95	90
106	86.2	100	50	88 m. pt.	100	100
108	90.8	105	66			105
110	95.4	110	88.5			110
112 m. pt.	100	114 m. pt.	100			112 m.



**MAGNESIUM BROMIDE COMPOUNDS** with Acetamide, Acetanilide and Acetic Anhydride.

(Menschutkin, 1909.)

compounds were prepared by reaction with magnesium bromide dietherate.

Solubility of $\text{MgBr}_2 \cdot 6\text{CH}_3\text{CONH}_2$ in Acetamide.			Solubility of $\text{MgBr}_2 \cdot 6\text{CH}_3\text{CONHC}_6\text{H}_5$ in Acetanilide.			Solubility of $\text{MgBr}_2 \cdot 6(\text{CH}_3\text{CO})_2\text{O}$ in Acetic Anhydride.		
Gms. $\text{MgBr}_2 \cdot 6\text{CH}_3\text{CONH}_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{MgBr}_2 \cdot 6\text{CH}_3\text{CONHC}_6\text{H}_5$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{MgBr}_2 \cdot 6(\text{CH}_3\text{CO})_2\text{O}$ per 100 Gms. Sat. Sol.		
pt. of $\text{CH}_3\text{CONH}_2$	$\text{CH}_3\text{CONH}_2$	112 m. pt.	pt. of $\text{CH}_3\text{CONHC}_6\text{H}_5$		o			
3.1	"	110	3.7	$\text{CH}_3\text{CONHC}_6\text{H}_5$	20	26.4		
21.7	"	108	7.7	"	40	28.7		
40	"			" + $\text{MgBr}_2 \cdot \text{CH}_3\text{CONHC}_6\text{H}_5$	60	31.6		
	$\text{CH}_3\text{CONH}_2 + \text{MgBr}_2$	107.5*	9	$\text{CONHC}_6\text{H}_5$	80	35.7		
56	$\text{CH}_3\text{CONH}_2$	120	13.1	$\text{MgBr}_2 \cdot \text{CH}_3\text{CONHC}_6\text{H}_5$	100	41.1		
57.8	$\text{MgBr}_2 \cdot \text{CH}_3\text{CONH}_2$	140	19.3	"	120	48.4		
60.5	"	160	25.5	"	130	57.8		
65	"	180	35.3	"	133	69.8		
71.5	"	200	59.5	"	135	77		
80	"	205	73.2	"	136.5†	85		
85	"	207	82.5	"		100		
90	"	209	100†	"				
100	"							

\* Eutec.

† m. pt.

**MAGNESIUM BROMIDE COMPOUNDS** with Urethan and with Urea.

(Menschutkin, 1909.)

Solubility of Magnesium Bromide Urethan Compounds in Urethan.			Solubility of Magnesium Bromide Urea Compounds in Urea.		
Gms. $\text{MgBr}_2 \cdot 4\text{C}_2\text{H}_4\text{OCONH}_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{MgBr}_2 \cdot 4\text{CO}(\text{NH}_2)_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.
40 m. pt. of urethan	$\text{C}_2\text{H}_5\text{OCONH}_2$	132	m. pt. of urea	$\text{CO}(\text{NH}_2)_2$	
45 18.5	"	126	9.5	"	
39 36.5	"	120	17.2	"	
35 43.3	" + $\text{MgBr}_2 \cdot 6\text{C}_2\text{H}_5\text{OCONH}_2$	114	21.8	"	
45 45.6	$\text{MgBr}_2 \cdot 6\text{C}_2\text{H}_5\text{OCONH}_2$	108.5*	24.2	$\text{CO}(\text{NH}_2)_2 + \text{MgBr}_2 \cdot 6\text{CO}(\text{NH}_2)_2$	
51.3	"	115	29.8	$\text{MgBr}_2 \cdot 6\text{CO}(\text{NH}_2)_2$	
56.2	"	120	35	"	
66.5	"	127	45.5	"	
75.5	"	130	60	"	
69.4	" + $\text{MgBr}_2 \cdot 4\text{C}_2\text{H}_5\text{OCONH}_2$	130†	58	" + $\text{MgBr}_2 \cdot 4\text{CO}(\text{NH}_2)_2$	
73.8	$\text{MgBr}_2 \cdot 4\text{C}_2\text{H}_5\text{OCONH}_2$	145	60.7	$\text{MgBr}_2 \cdot 4\text{CO}(\text{NH}_2)_2$	
80	"	160	67.2	"	
84.1	"	165	71.4	"	
90	"	170	83.7	"	
100	"	171	96	"	

\* Eutec.

† tr. pt.

**MAGNESIUM CAMPHORATE**  $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Mg} \cdot 14\text{H}_2\text{O}$ .**SOLUBILITY OF MAGNESIUM CAMPHORATE IN d CAMPHORIC ACID AT 15°**  
AND VICE VERSA.

(Jungfleisch and Landrieu, 1914.)

Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
$\text{C}_{10}\text{H}_{16}\text{O}_4$	$\text{C}_{10}\text{H}_{16}\text{O}_4\text{Mg}$	Solid Phase.	$\text{C}_{10}\text{H}_{16}\text{O}_4$	$\text{C}_{10}\text{H}_{16}\text{O}_4\text{Mg}$	Solid Phase.
0.622 (13.5°)	o	$\text{C}_{10}\text{H}_{16}\text{O}_4$	3.16	10.30	$\text{C}_{10}\text{H}_{16}\text{O}_4$
1.20	1.29	"	3.5	16.5	" + $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Mg} \cdot 14\text{H}_2\text{O}$
1.98	3.53	"	3.6	16.7	$\text{C}_{10}\text{H}_{16}\text{O}_4\text{Mg} \cdot 14\text{H}_2\text{O}$
2.36	5.66	"	1.91	15.1	"
2.85	8.19	"	o	14.25	"



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**MAGNESIUM CARBONATE**  $\text{MgCO}_3 \cdot 3\text{H}_2\text{O}$ .

**SOLUBILITY IN WATER IN PRESENCE OF CARBON DIOXIDE**

(Treadwell and Reuter — Z. anorg. Ch. 17, 200, '08.)

cc. $\text{CO}_2$ per 100 cc. Gas Phase (at $0^\circ$ and 760 mm.).	Partial Pressure of $\text{CO}_2$ in mm. Hg.	Grams per 100 cc. Solution.		
		Free $\text{CO}_2$ .	$\text{MgCO}_3$ .	$\text{Mg}(\text{HCO}_3)_2$ .
18.86	143.3	0.1190	...	1.2105
5.47	41.6	0.0866	...	1.2105
4.47	33.8	0.0035	...	1.2105
1.54	11.7	...	0.0773	1.0766
1.35	10.3	...	0.0765	0.7629
1.07	8.2	...	0.0807	0.5952
0.62	4.7	...	0.0701	0.3663
0.60	4.6	...	0.0758	0.3417
0.33	2.5	...	0.0748	0.2632
0.21	1.6	...	0.0771	0.2229
0.14	1.1	...	0.0710	0.2169
0.03	0.3	...	0.0711	0.2036
...	...	...	0.0685	0.2033
...	...	...	0.0702	0.1960
...	...	...	0.0625	0.2036
...	...	...	0.0616	0.1954
...	...	...	0.0641	0.1954

Therefore at 0 partial pressure of  $\text{CO}_2$  and at  $15^\circ$  and mean barome one liter of saturated aqueous solution contains 0.641 gm. of  $\text{MgCl}$  gms.  $\text{Mg}(\text{HCO}_3)_2$ .

It is pointed out by Johnston (1915) that although Treadwell and very painstaking analyses, their mode of working did not secure eqi ditions, a fact which is borne out by the lack of constancy of the ca bility-product constant.

**SOLUBILITY OF MAGNESIUM CARBONATE IN WATER CHARGEI  
BON DIOXIDE AT PRESSURES GREATER THAN ONE ATMC**

(Engel and Ville — Compt. rend. 93, 340, '81; Engel — Ann. chim. phys. [6] 13

Pressure of $\text{CO}_2$ in Atmospheres.	G. $\text{MgCO}_3^*$ per Liter.		Pressure of $\text{CO}_2$ in Atmospheres.	G. $\text{MgCO}_3^*$ pe	
	At $12^\circ$ .	At $19^\circ$ .		At $12^\circ$ .	At 1
0.5	20.5	...	4.0	42.8	...
1.0	26.5	25.8	4.7	...	43.5
2.0	34.2	33.1 (2.1 At.)	6.0	50.6	48.5
3.0	39.0	37.2 (3.2 At.)	9.0	...	56.6

**SOLUBILITY IN WATER SATURATED WITH  $\text{CO}_2$  AT ONE ATM**

(Engel.)

$t^\circ$ .	Gms. $\text{MgCO}_3^*$ per Liter.	$t^\circ$ .	Gms. $\text{MgCO}_3^*$ per Liter.	$t^\circ$ .	G
5	36	30	21	60	
10	31	40	17	80	
20	26			100	

Dissolved as  $\text{Mg}(\text{HCO}_3)_2$ .



Data for the system magnesium carbonate-carbonic acid-water at 20°, 25°, 30°, 34° and 39° are given by Leather and Sen (1914). In connection with these results, it is pointed out by Johnston (1915), that it is questionable whether equilibrium was really obtained and furthermore, the accuracy of the analytical results cannot be trusted since the ratio of total amount of CO<sub>2</sub> in solution, to the magnesia is very irregular. The results when plotted directly show great inconsistencies.

THE CALCULATED SOLUBILITY OF MgCO<sub>3</sub>·3H<sub>2</sub>O IN WATER AT 18° IN CONTACT WITH AIR CONTAINING PARTIAL PRESSURES OF CO<sub>2</sub> FROM 0.0002 TO 0.0005 ATMOSPHERES.

(Johnston, 1915.)

It is shown that if the CO<sub>2</sub> pressure is kept constant at  $P$  and the water evaporated off so slowly at 18° that equilibrium conditions are continuously maintained, the following amounts of Mg(OH)<sub>2</sub> or of MgCO<sub>3</sub>·3H<sub>2</sub>O will be obtained.

Partial Pressure $P$ of CO <sub>2</sub> in Atmos.	Total Mg $\frac{\text{Mols.}}{\text{l.}}$	Gms. per Liter.
0	0.00015	0.0087 Mg(OH) <sub>2</sub>
0.00020	0.01934	1.13 "
0.00025	0.02218	1.29 "
0.00030	0.02486	1.45 "
0.00035	0.02742	1.60 "
0.00040	0.02868	3.97 MgCO <sub>3</sub> ·3H <sub>2</sub> O
0.00045	0.02924	4.05 "
0.00050	0.02976	4.12 "

SOLUBILITY OF MAGNESIUM CARBONATE IN NATURAL WATERS.

(Wells, 1915.)

(In all cases the solutions were in equilibrium with atmospheric air at 20°.)

Mixture.	Milligrams per Liter of Sat. Solution.		
	Mg.	Free CO <sub>2</sub> .	CO <sub>2</sub> as Bi-carbonate.
Natural Magnesite in Distilled H <sub>2</sub> O	0.018	trace	0.065
" in Aq. NaCl (27.2 g. per l.)	0.028	trace	0.086
MgCO <sub>3</sub> ·3H <sub>2</sub> O (equilibrium from bicarbonate end)	0.038	0.28 CO <sub>2</sub> as carbonate	0.83
MgCO <sub>3</sub> ·3H <sub>2</sub> O ( " " undersaturation " )	0.034	0.32 CO <sub>2</sub> " "	0.59

SOLUBILITY OF MAGNESIUM CARBONATE IN AQUEOUS SOLUTIONS OF POTASSIUM BICARBONATE.

(Auerbach, 1904.)

The conditions necessary for preventing changes in equilibrium due to hydrolysis and loss of CO<sub>2</sub> are discussed. The mixtures were shaken from 1-4 days. The sat. sol. analyzed for total alkali  $\left(K + \frac{\text{Mg}}{2}\right)$  by titration with standard HCl using methyl orange as indicator. The neutralized solution was boiled to expel CO<sub>2</sub> and then excess 0.1  $N$  NaOH added and the filtrate from magnesium precipitate back titrated with 0.1  $N$  HCl. The  $\frac{\text{Mg}}{2}$  was calculated from the used 0.1  $N$  NaOH and the  $K$  obtained by difference.

Results at 15°.

Results at 25°.

Results at 35°.

Mols. per Liter.			Mols. per Liter.			Mols. per Liter.		
KHCO <sub>3</sub>	MgCO <sub>3</sub>	Solid Phase.	KHCO <sub>3</sub>	MgCO <sub>3</sub>	Solid Phase.	KHCO <sub>3</sub>	MgCO <sub>3</sub>	Solid Phase.
0	0.0095	MgCO <sub>3</sub> ·3H <sub>2</sub> O	0	0.0087	MgCO <sub>3</sub> ·3H <sub>2</sub> O	0	0.0071	MgCO <sub>3</sub> ·3H <sub>2</sub> O
0.0902	0.0131	"	0.0985	0.0115	"	0.1092	0.0098	"
0.1943	0.0167	"	0.2210	0.0149	"	0.2811	0.0142	"
0.3992	0.0211	" (labil)	0.3434	0.0181	"	0.4847	0.0177	"
0.7023	0.0192	" +1.1	0.4985	0.0217	" (labil)	0.5807	0.0198	" (labil)
0.5243	0.0097	1.1	0.3906	0.0196	" +1.1	0.5088	0.0184	" +1.1
0.6792	0.0074	"	0.5893	0.0128	1.1	0.6231	0.0153	1.1
0.981	0.0028	"	0.6406	0.0117	"	0.8535	0.0119	"
1.1 = MgCO <sub>3</sub> ·KHCO <sub>3</sub> ·4H <sub>2</sub> O.			1.125	0.0061	"			

Additional data for this system are given by Nanty, 1911.

Data for the solubility of MgCO<sub>3</sub> in aq. NaCl and other salt solutions, determined by prolonged boiling and subsequent cooling of the solution out of contact with air, are given by Gothe (1915).



# MAGNESIUM CARBONATE 386

SOLUBILITY OF MAGNESIUM CARBONATE IN AQUEOUS SOLUTIONS OF SODIUM CARBONATE AT 25°. The solutions being in equilibrium with an atmosphere free from CO<sub>2</sub>.

(Cameron and Seidell — J. Physic. Ch. 7, 588, '03.)

Wt. of 1 Liter of Solution.	Grams per Liter.		Reacting Weights per Liter.	
	Na <sub>2</sub> CO <sub>3</sub> .	MgCO <sub>3</sub> .	Na <sub>2</sub> CO <sub>3</sub> .	MgCO <sub>3</sub> .
996.8	0.00	0.223	0.000	0.00266
1019.9	23.12	0.288	0.220	0.00344
1047.7	50.75	0.510	0.482	0.00620
1082.5	86.42	0.879	0.820	0.01027
1118.9	127.3	1.314	1.209	0.01570
1147.7	160.8	1.636	1.526	0.01955
1166.1	181.9	1.972	1.727	0.02357
1189.4	213.2	2.317	2.024	0.02770

SOLUBILITY OF MAGNESIUM BICARBONATE AND OF MAGNESIUM CARBONATE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE AT 23°. The solutions being in equilibrium with an atmosphere of CO<sub>2</sub> in the one case, and in equilibrium with air free from CO<sub>2</sub> in the other.

(C. and S.)

In Presence of CO <sub>2</sub> as Gas Phase.		Wt. of 1 Liter.	In Presence of Air Free from CO <sub>2</sub> .	
Gms. NaCl per Liter.	Gms. Mg(HCO <sub>3</sub> ) <sub>2</sub> per Liter.		Gms. NaCl per Liter.	Gms. MgCO <sub>3</sub> per Liter.
7.0	30.64	996.9	0.0	0.176
56.5	30.18	1016.8	28.0	0.418
119.7	27.88	1041.1	59.5	0.527
163.9	24.96	1070.5	106.3	0.585
224.8	20.78	1094.5	147.4	0.544
306.6	10.75	1142.5	231.1	0.460
		1170.1	272.9	0.393
		1199.3	331.4	0.293

SOLUBILITY OF MAGNESIUM CARBONATE IN AQUEOUS SOLUTIONS OF SODIUM SULPHATE AT 24° AND AT 35.5°. The solutions being in equilibrium with an atmosphere free from CO<sub>2</sub>.

(Cameron and Seidell.)

Results at 24°.

Wt. of 1 Liter.	Gms. Na <sub>2</sub> SO <sub>4</sub> per Liter.	Gms. MgCO <sub>3</sub> per Liter.
007.5	0.00	0.216
1021.2	25.12	0.586
1047.6	54.76	0.828
1080.9	95.68	1.020
1133.8	160.8	1.230
1157.3	191.9	1.280
1206.0	254.6	1.338
1242.0	305.1	1.388

Results at 35.5°.

Wt. of 1 Liter.	Gms. Na <sub>2</sub> SO <sub>4</sub> per Liter.	Gms. MgCO <sub>3</sub> per Liter.
995.1	0.32	0.131
1032.9	41.84	0.577
1067.2	81.84	0.753
1094.8	116.56	0.904
1120.4	148.56	0.962
1151.7	186.7	1.047
1179.8	224.0	1.088
1236.5	299.2	1.130



**MAGNESIUM CHLORATE**  $\text{Mg}(\text{ClO}_3)_2 \cdot 6\text{H}_2\text{O}$ .**SOLUBILITY IN WATER.**

(Meusser — Ber. 35, 1416, '02.)

t°.	Gms. $\text{Mg}(\text{ClO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Mg}(\text{ClO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Mg}(\text{ClO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Mg}(\text{ClO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
-18	51.64	10.05	$\text{Mg}(\text{ClO}_3)_2 \cdot 6\text{H}_2\text{O}$	42	63.82	16.60	$\text{Mg}(\text{ClO}_3)_2 \cdot 4\text{H}_2\text{O}$
0	53.27	10.73	"	65.5	69.12	20.08	"
18	56.50	12.22	"	39.5	65.37	17.76	$\text{Mg}(\text{ClO}_3)_2 \cdot 3\text{H}_2\text{O}$
30	60.23	14.25	"	61.0	69.46	21.40	"
35	63.65	16.48	"	68	70.69	22.69	"
				93	(73.71)	(26.38)	"

Sp. Gr. of saturated sol. at + 18° = 1.564.

**MAGNESIUM CHLORIDE**  $\text{MgCl}_2$ .**SOLUBILITY IN WATER.**

(van't Hoff and Meyerhoffer, 1898; Engel; Lowenherz. Results quoted from Landolt and Börnstein, 1912.)

t°.	Gms. $\text{MgCl}_2$ per 100 Gms Solution.	Water.	Solid Phase.	t°.	Gms. $\text{MgCl}_2$ per 100 Gms Solution.	Water.	Gms. Solid Phase.
-10	11.1	12.5	Ice	0	34.5	52.8	$\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$
-20	16.0	19.0	"	10	34.9	53.5	"
-30	19.4	24.0	"	20	35.3	54.5	"
-33.6	20.6	26.0	Ice + $\text{MgCl}_2 \cdot 12\text{H}_2\text{O}$	22	35.6	55.2	"
-20	26.7	36.5	$\text{MgCl}_2 \cdot 12\text{H}_2\text{O}$	25	36.2	56.7	"
-16.4	30.6	44.04 f. pt.	"	40	36.5	57.5	"
-16.8	31.6	46.2	$\text{MgCl}_2 \cdot 12\text{H}_2\text{O} +$ $\text{MgCl}_2 \cdot 8\text{H}_2\text{O} \alpha$	60	37.9	61.0	"
-17.4	32.3	47.6*	$\text{MgCl}_2 \cdot 12\text{H}_2\text{O} +$ $\text{MgCl}_2 \cdot 8\text{H}_2\text{O} \beta$	80	39.8	66.0	"
-19.4	33.3	49.9*	$\text{MgCl}_2 \cdot 12\text{H}_2\text{O} +$ $\text{MgCl}_2 \cdot 6\text{H}_2\text{O} \beta$	100	42.2	73.0	"
-9.6	33.9	51.3*	$\text{MgCl}_2 \cdot 8\text{H}_2\text{O} \beta$ + $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$	116.7	46.2	85.5	$\text{MgCl}_2 \cdot 6\text{H}_2\text{O} +$ $\text{MgCl}_2 \cdot 4\text{H}_2\text{O}$
-3.4	34.4	52.3	$\text{MgCl}_2 \cdot 8\text{H}_2\text{O} \alpha +$ $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$	152.6	49.1	96.4	$\text{MgCl}_2 \cdot 4\text{H}_2\text{O}$
			about	181.5	55.8	126.0	$\text{MgCl}_2 \cdot 4\text{H}_2\text{O} +$ $\text{MgCl}_2 \cdot 2\text{H}_2\text{O}$
				186	56.1	128.0	$\text{MgCl}_2 \cdot 2\text{H}_2\text{O}$

\* = Unstable.

**SOLUBILITY OF MAGNESIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 0°.**

(Engel — Compt. rend. 104, 433, '87.)

Milligram Mols. per 10 cc. Solution.		Sp. Gr. of Solutions.	Grams per Liter of Solution.	
HCl.	$\frac{1}{2}\text{MgCl}_2$ .		HCl.	$\text{MgCl}_2$ .
0.0	99.55	1.362	0.0	474.2
4.095	95.5	1.354	14.93	454.8
9.5	90.0	1.344	34.63	428.6
17.0	82.5	1.300	61.97	393.0
20.5	79.0	1.297	74.74	376.2
28.5	71.0	1.281	103.9	338.3
42.0	60.125	...	153.1	286.4
58.75	46.25	...	214.2	220.3
76.0	32.0	...	277.1	152.0
			sat. HCl (Ditte)	6.5

100 gms.  $\text{H}_2\text{O}$  dissolve 52.65 gms.  $\text{MgCl}_2$  at 3.5°, 55.26 gms. at 25° and 58.66 gms. at 50°. (Biltz and Marcus, 1911.)



## SOLUBILITY OF BASIC MAGNESIUM CHLORIDE IN WATER AT 25°.

(Robinson and Waggaman, 1909.)

An excess of MgO was shaken with each of 20 MgCl<sub>2</sub> solutions at 25° for months and the supernatant clear solutions and solid phases with adhering liquid analyzed. The solutions were titrated with 0.02 N HCl for dissolved (present as Mg(OH)<sub>2</sub>). The composition of the solid phase in each case ascertained by plotting the analytical results on a triangular diagram.

$d_m$ of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.*	$d_m$ of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	MgCl <sub>2</sub> .	MgO.			MgCl <sub>2</sub> .	MgO.	
1.019	2.36	0.00008	Indefinite	1.141	17.53	0.0024	2MgO.HCl.5
1.038	4.47	0.00028	Solid Solution	1.162	18.52	0.0025	"
1.056	6.79	0.00048	"	1.192	22.04	0.00245	"
1.075	9.02	0.00080	"	1.245	26.88	0.0025	"
1.111	13.14	0.00115	"	1.274	29.80	0.0024	"
				1.321	34.22	0.0030	"

## SOLUBILITY OF MIXTURES OF MAGNESIUM CHLORIDE, POTASSIUM CHLORIDE AND OF MAGNESIUM POTASSIUM CHLORIDE (CARNALLITE) IN WATER AT VARIOUS TEMPERATURES.

(van't Hoff and Meyerhoffer, 1899, 1912.)

t°.	Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.	Kind of Point on Curve.
	MgCl <sub>2</sub> .	KCl.		
- 11.1	...	24.6	Ice + KCl	Cryohydric of KCl
- 33.6	26	...	" + MgCl <sub>2</sub> .12H <sub>2</sub> O	" MgCl <sub>2</sub> .12H <sub>2</sub> O
- 34.3	22.7	1.24	" + KCl + MgCl <sub>2</sub> .12H <sub>2</sub> O	"
- 21	34.9	2.03	Carnallite + MgCl <sub>2</sub> .12H <sub>2</sub> O + KCl	Formation Temp. of Carnal
- 0	35.5	3.02	" + KCl	Point on Curve
25	38.4	4.76	" + "	" "
50	42	6.17	" + "	" "
61.5	42.6	7.20	" + "	" "
154.5	65.5	14.07	" + "	" "
167.5	88.1	17.26	" + "	" "
25	55.5	0.83	" + MgCl <sub>2</sub> .6H <sub>2</sub> O	M. pt. of Carnallite
50	59.13	0.50	" + "	Point on Curve
80	65	1.24	" + "	" "
115.7	85.6	1.66	" + " + MgCl <sub>2</sub> .4H <sub>2</sub> O	Transition Point [Carn]
152.5	105.7	9.93	" + MgCl <sub>2</sub> .4H <sub>2</sub> O + KCl	Upper Formation Temp. of
176	126.9	16.97	MgCl <sub>2</sub> .4H <sub>2</sub> O + MgCl <sub>2</sub> .2H <sub>2</sub> O + KCl	Transition Point
186	126.9	26.1	MgCl <sub>2</sub> .2H <sub>2</sub> O + KCl	Point on Curve

Carnallite = MgKCl<sub>3</sub>.6H<sub>2</sub>O.

## SOLUBILITY OF MIXTURES OF MAGNESIUM CHLORIDE AND OTHER SALTS IN WATER AT 25°.

(Löwenherz, 1894.)

Mixture.	Gms. Mols. per 1000 Mols. H <sub>2</sub> O.		Gms. per Liter of Solution
	MgCl <sub>2</sub> .	MgSO <sub>4</sub> .	
MgCl <sub>2</sub> .6H <sub>2</sub> O + MgSO <sub>4</sub> .6H <sub>2</sub> O	104	14	25. Cl + 4.4 SO <sub>4</sub>
MgCl <sub>2</sub> .7H <sub>2</sub> O + MgSO <sub>4</sub> .6H <sub>2</sub> O	73	15	19.5 Cl + 5.3 SO <sub>4</sub>
MgCl <sub>2</sub> .6H <sub>2</sub> O + MgCl <sub>2</sub> .KCl.6H <sub>2</sub> O	106	Cl <sub>2</sub> + 1 K <sub>2</sub> + 105 Mg	26.9 Cl + 0.3 K + 45.

Results for all possible combinations of magnesium sulfate and potassium chloride and of magnesium chloride and potassium sulfate are also given.

100 cc. anhydrous hydrazine dissolve 2 gms. MgCl<sub>2</sub> at room temp. A flocculent ppt. separates on standing. (Welsh and Broderick, 1911.)

Freezing-point data (solubility, see footnote, p. 1) for mixtures of MgCl<sub>2</sub>, KCl, NaCl, AgCl, ZnCl<sub>2</sub> and SnCl<sub>2</sub> are given by Menge (1911). Data for mixtures of MgCl<sub>2</sub> + SrCl<sub>2</sub> and MgCl<sub>2</sub> + MnCl<sub>2</sub> are given by Sandonini (1912, 15). Data for MgCl<sub>2</sub> + MgSO<sub>4</sub> are given by Jaenecke (1912). Data for MgCl<sub>2</sub> + KCl are given by Korreng (1914) and data for MgCl<sub>2</sub> + KCl and MgCl<sub>2</sub> + HCl are given by Dornby (1918).



**MAGNESIUM CINNAMATE**  $(C_6H_5CH.CH.COO)_2Mg.H_2O$ .

100 gms. sat. solution in water contain 0.85 gm.  $(C_6H_5CH.CH.COO)_2Mg$  at 15° and 1.94 gms. at 100°.

(Tarugi and Checchi, 1901.)

**MAGNESIUM CHROMATE**  $MgCrO_4.7H_2O$ .

100 grams  $H_2O$  dissolve 72.3 grams  $MgCrO_4$  at 18°, or 100 grams solution contain 42.0 grams. Sp. Gr. = 1.422.

(Mylus and Funk, 1897.)

**MAGNESIUM POTASSIUM CHROMATE**  $MgCrO_4.K_2CrO_4.2H_2O$ .

100 grams  $H_2O$  dissolve 28.2 grams at 20°, and 34.3 grams at 60°.

(Schweitzer.)

**MAGNESIUM PLATINIC CYANIDE**  $MgPt(CN)_6$ .

## SOLUBILITY IN WATER.

(Buxhoeveden and Tamman — Z. anorg. Ch. 15, 319 '97.)

t°.	Gms. $MgPt(CN)_6$ per 100 Gms. Solution.	Solid Phase.	t°.	Gms. $MgPt(CN)_6$ per 100 Gms. Solution.	Solid Phase.
-4.12	24.90	$MgPt(CN)_6.6.8-8.1H_2O$	48.7	40.89	$MgPt(CN)_6.4H_2O$
0.5	26.9	" (Red)	55	41.33	"
5.5	28.65	"	58.1	42.15	"
18.0	32.46	"	69.0	43.40	"
36.6	39.53	"	77.8	44.90	"
45.0	41.33	"	87.4	45.52	"
46.2	42.0	"	90.0	45.65	"
42.2	40.21	$MgPt(CN)_6.4H_2O$	93.0	45.04	"
46.3	39.85	" (Bright Green)	96.4	44.33	$MgPt(CN)_6.3H_2O$
			100.0	44.0	" (White)

**MAGNESIUM FERROCYANIDES.**

## SOLUBILITY IN WATER AT 17°.

(Robinson, 1909.)

One liter sat. sol. contains 1.95 gms. magnesium potassium ferrocyanide,  $MgK_4FeC_6N_6$ .

One liter sat. sol. contains 2.48 gms. magnesium ammonium ferrocyanide,  $Mg(NH_4)_4FeC_6N_6$ .

**MAGNESIUM FLUORIDE**  $MgF_2$ .

One liter of water dissolves 0.076 gm.  $MgF_2$  at 18° by conductivity method.

(Kohlrausch, 1905.)

One liter water dissolves 0.087-0.090 gm.  $MgF_2$  at 0.3° and 0.084 gm. at 27° by conductivity method.

(Kohlrausch, 1908.)

**MAGNESIUM HYDROXIDE**  $Mg(OH)_2$ .

One liter of water dissolves 0.008 — 0.009 gm.  $Mg(OH)_2$  at 18° by conductivity method.

(Dupre and Brutus, 1903.)

One liter of water dissolves 0.009 gm.  $Mg(OH)_2$  at 18° by conductivity method (Kohlrausch and Rose, 1893), 0.012 gm. (Tamm, 1910).

## SOLUBILITY OF MAGNESIUM OXIDE IN AQUEOUS SOLUTIONS CONTAINING SODIUM CHLORIDE AND SODIUM HYDROXIDE.

(Maigret, 1905.)

Gms. NaCl per Liter.	Gms. MgO per Liter Solution with Added:	
	0.8 g. NaOH per Liter.	4.0 g. NaOH per Liter.
125	0.07	0.03
140	0.045	...
160	none	none



# MAGNESIUM HYDROXIDE 390

## SOLUBILITY OF MAGNESIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE AND OF AMMONIUM NITRATE AT 29°.

(Herz and Muhs — Z. anorg. Ch. 38, 140, '04.)

NOTE. — Pure  $Mg(OH)_2$  was prepared and an excess shaken with solutions of ammonium chloride and of ammonium nitrate of different concentrations.

Concentration of $NH_4Cl$ or of $NH_4NO_3$ (Normal.)	Acid Required for Liberated $NH_4OH$ in 25 cc. (Normal.)	Normality of:		Grams per Liter.	
		$Mg(OH)_2$	$NH_4Cl$	$Mg(OH)_2$	$NH_4Cl$
.7 ( $NH_4Cl$ )	0.09835	0.156	0.388	4.55	20.86
0.466 "	0.1108	0.108	0.250	3.15	13.39
0.35 "	0.09835	0.089	0.172	2.60	9.21
0.233 "	0.1108	0.0638	0.106	1.86	5.67
0.175 "	0.1108	0.049	0.0771	1.43	4.13
0.35 ( $NH_4NO_3$ )	0.1108	0.0833	0.1834	2.43	14.69 ( $NH_4NO_3$ )
0.175 "	0.1108	0.0495	0.076	1.45	6.09 "

## MAGNESIUM IODATE $Mg(IO_3)_2$ .

### SOLUBILITY IN WATER.

(Mylius and Funk — Ber. 30, 1722, '97; Wiss. Abh. p. t. Reichsanstalt 3, 446, '00.)

t°.	Gms. $Mg(IO_3)_2$ per 100 Gms. Solution.	Mols. $Mg(IO_3)_2$ per 100 Mols. $H_2O$ .	Solid Phase.	t°.	Gms. $Mg(IO_3)_2$ per 100 Gms. Solution.	Mols. $Mg(IO_3)_2$ per 100 Mols. $H_2O$ .	Solid Phase.
0	3.1	0.15	$Mg(IO_3)_2 \cdot 10H_2O$	0	6.8	0.34	$Mg(IO_3)_2 \cdot 4H_2O$
20	10.2	0.55	"	10	6.4	0.30	"
30	17.4	1.01	"	18	7.6	0.40	"
35	21.9	1.35	"	20	7.7	0.40	"
50	67.5	10.0	"	35	8.9	0.47	"
				63	12.6	0.69	"
				100	19.3	1.13	"

Sp. Gr. of solution sat. at 18° = 1.078.

## MAGNESIUM IODIDE $MgI_2 \cdot 8H_2O$ .

SOLUBILITY IN WATER. (Menschutkin, 1905, 1907.)

The salt was prepared by the action of water upon magnesium iodide dieth (see p. 391) by which the octahydrate and not the hexahydrate is formed. crystals of this hydrate melt at 43.6°. The solubility determinations were by the synthetic method.

t°.	Gms. per 100 Gms. Sat. Solution.		Solid Phase.
	$MgI_2 \cdot 6H_2O$	$MgI_2$	
0	76	54.7	$MgI_2 \cdot 8H_2O$
18	...	59.7 ( $d=1.909$ )	"
20	81	58.3	"
40	88	63.4	"
43.5 tr. pt.	90.8	65.4	" + $MgI_2 \cdot 6H_2O$
43	89.8	64.7	$MgI_2 \cdot 6H_2O$
80	90.3	65	"
120	90.9	65.4	"
160	91.7	66	"
200	93.4	67.2	"
215	94.3	67.9	"

(Mylius and Funk,



## MAGNESIUM IODIDE ETHERATES, ALCOHOLATES, ACIDATES, etc.

## SOLUBILITIES RESPECTIVELY IN ETHER, ALCOHOL AND ACID SOLVENTS AT VARIOUS TEMPERATURES.

**Schutkin.** Monograph in the Russian Language entitled "On Etherates and Other Moleculations of Magnesium Bromide and Iodide," St. Petersburg, 1907, pp. 267 + XLVIII. Published in "Memoirs of the St. Petersburg Polytechnic Institute," vols. 1-7, 1904-07 and in condensed form in vols. 49-67 of the *Zeit. anorg. Chem.*, 1906-09.

**Preparation of Material.** The dietherate of magnesium iodide,  $MgI_2 \cdot 2C_4H_{10}O$ , is prepared by the very gradual addition of iodine to a mixture of magnesium iodide and ether. The reaction is not so violent as that which takes place during the preparation of the magnesium bromide dietherate (see p. 379). Two liquid layers are present at the end of the reaction and by slight cooling beautiful white crystals separate from the lower one. The growth of these crystals is accompanied, as in the case of the magnesium bromide compound, by an evolution of ether droplets. Magnesium iodide dietherate is very hygroscopic, more soluble than magnesium bromide dietherate, and becomes yellowish even after several hours, and brown after a day, owing probably to separation of iodine. As in the case of the magnesium bromide compound it reacts with very many organic compounds as alcohols, acids, ketones, etc., with liberation of ether and formation of addition products. These latter constitute the material used in the following solubility studies.

**Method of Determination of Solubility.** The synthetic (sealed tube) method of Alexejeff (*Wied. Ann.*, 1885) was used almost exclusively.

**Summary of Results.** As is seen from the following table, the solubility of magnesium iodide dietherate increases much more rapidly with temperature than in the case of magnesium bromide dietherate, especially in the vicinity of the melting point of  $MgI_2 \cdot 2C_4H_{10}O$ , which is at  $23.6^\circ$ . At this temperature there appears a two-layered solution, the lower one of which may be considered as a solution of ether in ether, and the upper one as a solution of the lower layer in ether. By increasing the temperature a point is reached, at which both layers are miscible in all proportions (critical point). In the case of magnesium bromide dietherate no such critical point could be obtained. Both layers may be cooled below  $23.6^\circ$ , to about  $+15^\circ$  since here spontaneous crystallization of the dietherate from the lower layer occurs, and the temperature rises to  $23.6^\circ$ . The great tendency to crystallize is probably due to the difference between the composition of the mixture and of the saturated solution of the dietherate. The determinations of the critical point were quite difficult to make on account of the appearance of opalescence which occurred and also the formation of a white precipitate, the nature of which was not ascertained. The critical concentration, determined by means of the law of straight averages of Cailletet and Mathias, is approximately 40.3 per cent  $MgI_2 \cdot 2(C_4H_9)_2O$ ; the temperature,  $38.5^\circ$ . At concentrations of  $MgI_2 \cdot 2C_4H_{10}O$  greater than 54 per cent, a single liquid is again obtained and the solubility curve can be followed up to the melting point of the dietherate at  $51^\circ$ .



## SOLUBILITY OF MAGNESIUM IODIDE DIETHERATE IN ETHER AT DIFFERENT TEMPERATURES. (Menschutkin, 1906.)

t°.	Gms. per 100 Gms. Sat. Sol.		Mols. $\text{MgI}_2 \cdot 2(\text{C}_2\text{H}_5)_2\text{O}$ per 100 Mols. Sat. Sol.	Solid Phase
	$\text{MgI}_2 \cdot 2(\text{C}_2\text{H}_5)_2\text{O} = \text{MgI}_2$	$\text{MgI}_2$		
5.4	2.2	1.45	0.39	$\text{MgI}_2 \cdot 2(\text{C}_2\text{H}_5)_2\text{O}$
11.8	3.7	2.43	0.66	"
15.6	5.3	3.46	0.96	"
18.1	8.3	5.4	1.55	"
20.4	11.6	7.55	2.24	"
22.2	17.3	11.28	3.56	"
23.6	22	14.4	4.67	"

Between these two concentrations of  $\text{MgI}_2 \cdot 2(\text{C}_2\text{H}_5)_2\text{O}$  two liquid layers separate (see below).

23.6	54.4	35.5	17.1	"
25	73	47.6	31.9	"
30	82.5	54	42.9	"
35	87	57	53.4	"
40	89.6	58.6	60.4	"
45	93.5	61.2	71.4	"
51.5 m. pt.	100	65.2	100	"

At 23.6° the saturated solution separates into two liquid layers which have the following composition at different temperatures.

	Gms. per 100 Gms. Solution.				
t°.	Lower Layer.		Upper Layer.		
	MgI <sub>2</sub> .2(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O =	MgI <sub>2</sub> .	MgI <sub>2</sub> .2(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O =	MgI <sub>2</sub> .	
15	54.4	35.5	20.5	13.4	unstable
20	54.4	35.5	21.5	14.1	"
25	54.4	35.5	22.5	14.7	stable
30	54.4	35.5	23.5	15.4	"
35	54.1	35.3	26	17	"
36	53.5	34.9	27	17.7	"
37	52.2	34.2	28.5	18.7	"
38	50.5	33.1	32	21	"
38.5 crit. temp.	40.3	26.3	40.3	26.3	

## MAGNESIUM IODIDE ALCOHOLATES and ANILINATE.

SOLUBILITY OF EACH IN THE RESPECTIVE ALCOHOLS OR ANILINE. (Menschutkin.)

$\text{MgI}_2 \cdot 6\text{CH}_3\text{OH}$ in Methyl Alcohol.		$\text{MgI}_2 \cdot 6\text{C}_2\text{H}_5\text{OH}$ in Ethyl Alcohol.		$\text{MgI}_2 \cdot 6\text{C}_6\text{H}_5\text{NH}_2$ in Aniline.		$\text{MgI}_2 \cdot 6(\text{CH}_3)_2\text{CHOH}$ in Dimethyl Carbinol.	
t°.	Gms. $\text{MgI}_2 \cdot 6\text{CH}_3\text{OH}$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{MgI}_2 \cdot 6\text{C}_2\text{H}_5\text{OH}$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{MgI}_2 \cdot 6\text{C}_6\text{H}_5\text{NH}_2$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{MgI}_2 \cdot 6(\text{CH}_3)_2\text{CHOH}$ per 100 Gms. Sat. Sol.
0	49.6	0	21.9	0	3.3	10	57.1
20	52.6	20	33.2	60	3.9	30	60
40	55.3	40	44.4	100	5	50	63.3
60	58.8	60	55.3	130	8.5	70	67
80	60.6	80	65.5	150	17.5	90	71.2
100	63.3	100	74.7	170	38	110	76.2
120	66.2	120	82.7	180	52	120	79.4
140	69.5	130	87.2	188†	64.5	130	84.8
160	73.2	140	93.3	200	65.9*	136	91.7
180	77.1	143	96	210	67.2*	138†	100
200	81.5	146.5†	100	230	69.8*		

\* Solid Phase,  $\text{MgI}_2 \cdot 4\text{C}_6\text{H}_5\text{NH}_2$ . † M. pt. ‡ Tr. pt.



## MAGNESIUM IODIDE COMPOUNDS.

SOLUBILITY OF MAGNESIUM IODIDE COMPOUNDS WITH BENZALDEHYDE, ACETONE, ACETAL, AND ACETIC ACID IN EACH OF THESE LIQUIDS.

(Menschutkin.)

$6C_6H_5COH$ aldehyde.	$MgI_2 \cdot 6CH_3COCH_3$ in Acetone.	$MgI_2 \cdot 2CH_3CH(OC_2H_5)_2$ in Acetal.	$MgI_2 \cdot 6CH_3COOH$ in Acetic Acid.			
Gms. $MgI_2 \cdot 6C_6H_5COH$ per 100 Gms. Sat. Sol.	t°.	Gms. $MgI_2 \cdot 6CH_3COCH_3$ per 100 Gms. Sat. Sol.	t°.	Gms. $MgI_2 \cdot 2CH_3CH(OC_2H_5)_2$ per 100 Gms. Sat. Sol.	t°.	Gms. $MgI_2 \cdot 6CH_3COOH$ per 100 Gms. Sat. Sol.
3.2	0	4.9	20	0.15	20	0.6
3.8	30	6.7	60	0.45	40	2
5.3	50	8.3	77	0.60	60	5
7.7	60	10.2	(Between these two concentrations the mixture separates into two liquid layers.)		70	9.5
11	70	15.2			80	18.5
18.5	80	28.6			95	42
26.5	85	40	77	92	105	54.5
40	90	59.2	79	93.7	115	65
53	95	80	81	95.5	125	73.8
74.5	100	92.5	83	97.3	135	85
94.2	105	98.5			140	94
t. 100	106.5 m. pt. 100		86 m. pt. 100		142 m. pt. 100	

account of the properties of these molecular compounds, their great hygroscopy, etc., the solubility determinations are not strictly accurate in all cases.

## SOLUBILITY OF MAGNESIUM IODIDE COMPOUNDS WITH FORMIC AND ACETIC ACID ESTERS IN THE RESPECTIVE ESTERS.

(Menschutkin.)

$HCOOC_2H_5$ ,  $MgI_2 \cdot 6CH_3COOCH_3$ ,  $MgI_2 \cdot 6CH_3COOC_2H_5$ ,  $MgI_2 \cdot 6CH_3COOC_3H_7$   
in Formate. in Methyl Acetate. in Ethyl Acetate. in Propyl Acetate.

Gms. $MgI_2 \cdot 6HCOOC_2H_5$ per 100 Gms. Sat. Sol.	t°.	Gms. $MgI_2 \cdot 6CH_3COOCH_3$ per 100 Gms. Sat. Sol.	t°.	Gms. $MgI_2 \cdot 6CH_3COOC_2H_5$ per 100 Gms. Sat. Sol.	t°.	Gms. $MgI_2 \cdot 6CH_3COOC_3H_7$ per 100 Gms. Sat. Sol.
15.1	0	0.4	0	3.2	0	4.1
17.4	60	0.75	20	4.8	20	5.4
20.5	90	0.9	40	8.6	30	6.5
25	100	1.8	50	13.7	35	7.8
31.8	103	2.4	55	21.5	40	19
44	(Two layers here.)		60	38	45	46
68	103	74.2	65	63.5	50	72.5
m. pt. 100	110	81.7	70	90.5	55	88.2
	120	98	75	92.7	60	96
	121 m. pt. 100		78.5 m. pt. 100		65 m. pt. 100	

$MgI_2 \cdot 6CH_3COO$  (iso)  $C_4H_9$   
in Isobutyl Acetate.

t°.	Gms. $MgI_2 \cdot 6CH_3COO$ (iso) $C_4H_9$ per 100 Gms. Sat. Sol.
0	10.5
20	13.6
40	17.6
60	24.9
70	33.7
80	52
85	89
87.5 m. pt.	100

$MgI_2 \cdot 6CH_3COO$  (iso)  $C_5H_{11}$   
in Isoamyl Acetate.

t°.	Gms. $MgI_2 \cdot 6CH_3COO$ (iso) $C_5H_{11}$ per 100 Gms. Sat. Sol.
0	7.7
20	11.5
40	20.9
45	25.5
50	33.2
55	47.8
57.5	63
60 m. pt.	100



## SOLUBILITY OF MAGNESIUM IODIDE COMPOUNDS WITH ACETONITRILE, AND URETHAN IN THESE LIQUIDS. (Menschutkin.)

MgI <sub>2</sub> .6CH <sub>3</sub> CN in Acetonitrile.		MgI <sub>2</sub> .6CH <sub>3</sub> CONH <sub>2</sub> in Acetamide.		Solid Phase.	MgI <sub>2</sub> .6NH <sub>2</sub> CO in Urethane.	
t°.	Gms. MgI <sub>2</sub> .- 6CH <sub>3</sub> CN per 100 Gms. Sat. Sol.	t°.	Gms. MgI <sub>2</sub> .- 6CH <sub>3</sub> CONH <sub>2</sub> per 100 Gms. Sat. Sol.		t°.	Gms. MgI <sub>2</sub> .- 6NH <sub>2</sub> COOC, H <sub>2</sub> per 100 Gms. Sat. Sol.
82 m. pt. of acetamide					49 m. pt. of urethan	
0	37.2	70	28	CH <sub>3</sub> CONH <sub>2</sub>	45	27.5 NH <sub>2</sub> COOC
30	49.8	58	46.7	"	39	45 "
50	58.2	49*	56.5	" + MgI <sub>2</sub> .6CH <sub>3</sub> CONH <sub>2</sub>	32*	51.8 " + MgI <sub>2</sub>
70	67.9	80	63.4	MgI <sub>2</sub> .6CH <sub>3</sub> CONH <sub>2</sub>	40	55 MgI <sub>2</sub> .N
75	71.7	130	76	"	60	64.7
80	76.5	160	85.5	"	80	78.8
85	83	170	90.8	"	86	92.5
89	91.3	177†	100	"	87†	100
* Eutec.				† m. pt.		

MAGNESIUM IODOMERCURATE MgI<sub>2</sub>.2HgI<sub>2</sub>.7H<sub>2</sub>O.

The sat. solution in water at 17.8° has the composition MgI<sub>2</sub>.1.29Hg and Sp. Gr. 2.92.

MAGNESIUM DILACTATE Mg(C<sub>4</sub>H<sub>7</sub>O<sub>2</sub>).6H<sub>2</sub>O racemic, Mg(C<sub>4</sub>H<sub>7</sub>O<sub>2</sub>)<sub>2</sub> inactive.

## SOLUBILITY OF RACEMIC AND OF INACTIVE MAGNESIUM DILACTATE (Jungfleisch, 1912.)

100 gms. H<sub>2</sub>O dissolve 7 to 8 gms. racemic and 2.28 gms. inactive lac

## MAGNESIUM LAURATE, MYRISTATE, PALMITATE and ST

## SOLUBILITY OF EACH IN SEVERAL SOLVENTS. (Jacobson and Holme

Gms. Each Salt Determined Separately per 100.G

Solvent.	t°.	Mg Laurate (C <sub>12</sub> H <sub>25</sub> COO) <sub>2</sub> Mg.	Mg Myristate (C <sub>14</sub> H <sub>27</sub> COO) <sub>2</sub> Mg.	Mg Palmitate (C <sub>16</sub> H <sub>33</sub> COO) <sub>2</sub> Mg.
Water	15	0.010	0.006	0.005
"	25	0.007	0.006	0.008
"	35	0.010	0.007	0.006
"	50	0.026	0.014	0.009
Abs. Ethyl Alcohol	15	0.519	0.158	0.034
"	25	0.591	0.236	0.058
"	35	0.805	0.373	0.085
"	50	1.267	0.577	0.151
Methyl Alcohol	15	1.095	0.571	0.227
"	25	1.108	0.763	0.36
"	51.5	...	...	0.50
Ether	25	0.015	0.010	0.004
Ethyl Acetate	15	0.004	0.004	0.004
"	35	0.011	0.010	0.007
"	50	0.024	0.021	0.013
Amyl alcohol	15	0.191	0.086	0.043
"	25	0.236	0.145	0.066
"	35	1.481	0.438	0.104
"	50	4.869	1.893	0.263
Amyl Acetate	15	0.119	0.063	0.039
"	25	0.162	0.073	0.045
"	34.6	0.259	0.105	0.057
"	50	1.939	0.605	0.216



**MAGNESIUM NITRATE**  $\text{Mg}(\text{NO}_3)_2$ .

## SOLUBILITY IN WATER.

(Funk — Wiss. Abh. p. 1. Reichenstalt 3, 437, '00.)

S. [O <sub>2</sub> ] Gms. tion.	Mols. Mg(NO <sub>3</sub> ) <sub>2</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.	t°.	Gms. Mg(NO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Solution.	Mols. Mg(NO <sub>3</sub> ) <sub>2</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.
-44	6.6	Mg(NO <sub>3</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	40	45.87	10.3	Mg(NO <sub>3</sub> ) <sub>2</sub> ·6H <sub>2</sub> O
-19	7.0	"	80	53.69	14.6	"
1.03	7.4	"	90	57.81	16.7	"
3.03	7.37	Mg(NO <sub>3</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	89	63.14	20.9	} *
9.50	7.92	"	77.5	65.67	23.2	
9.96	8.08	"	67	67.55	25.1	
2.33	8.9	"				
				* Reverse curve.		

\* Reverse curve.

of solution saturated at  $18^\circ = 1.384$ .etic is at  $-29^\circ$  and 34.6 gms.  $\text{Mg}(\text{NO}_3)_2$  per 100 gms. sat. solution.oint data for  $\text{Mg}(\text{NO}_3)_2 + \text{Zn}(\text{NO}_3)_2$  are given by Vasilev (1909).r  $\text{Mg}(\text{NO}_3)_2 + \text{HNO}_3$  are given by Dernby (1918).**MAGNESIUM OLEATE**  $(\text{CH}_3(\text{CH}_2)_{13}\text{CH}_2\text{CH}_2\text{COO})_2\text{Mg}$ .H<sub>2</sub>O dissolves about 0.23 gm. oleate (soap).

(Fabrion, 1916.)

glycerol (*d* 1.114) dissolve 0.94 gm. oleate.

(Asselin, 1873.)

**MAGNESIUM OXALATE**  $\text{MgC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ .of water dissolves 0.3 gm.  $\text{MgC}_2\text{O}_4$  at  $18^\circ$  (conductivity method).

(Kohlrausch, 1905.)

**MAGNESIUM OXIDE**  $\text{MgO}$ .oint data (quenching method) for  $\text{MgO} + \text{SiO}_2$  are given by Bowen  
on, 1914.**MAGNESIUM PHOSPHATE**  $\text{MgHPO}_4 \cdot 3\text{H}_2\text{O}$ .OF MAGNESIUM PHOSPHATE IN AQUEOUS SOLUTIONS OF PHOSPHORIC  
ACID AT  $25^\circ$ . (Cameron and Bell, 1907.)ures were constantly agitated for two months and the clear solutions  
r magnesia and phosphoric acid.

gms. per Liter.	Solid Phase.	$d_{20}$ of Sat. Sol.	Gms. per Liter.		Solid Phase.
			$\text{MgO}$ .	$\text{P}_2\text{O}_5$ .	
07	$\text{MgHPO}_4 \cdot 3\text{H}_2\text{O}$	...	109.5	439	$\text{MgHPO}_4 \cdot 3\text{H}_2\text{O}$
80	"	1.470	122.6	408	"
53	"	...	129.9	546.5	"
38	"	...	140	584	"
3	"	1.595	146.8	623.3	"
3	"	...	147.3	625.9	"
9	"	...	150.3	645.8	"
3	"	...	155.5	680.7	"
9	"	...	160	700	"
0	"	1.626	87.1	779.6	$\text{MgH}_2(\text{PO}_4)_2 \cdot \text{XH}_2\text{O}$
281.8	"	1.644	77.1	809.6	"
	"	1.654	70.6	835.1	"

**MAGNESIUM (Hypo) PHOSPHATE**  $\text{Mg}_2\text{P}_2\text{O}_6 \cdot 12\text{H}_2\text{O}$ .

of water dissolves 0.066 gm. hypophosphate.

(Salzer, 1886.)

of water dissolves 5 gms. magnesium hydrogen hypophosphate,  
 $\text{H}_2\text{O}$ .

(Salzer.)

**MAGNESIUM SALICYLATE**  $\text{Mg}(\text{C}_7\text{H}_5\text{O}_2)_2 \cdot 4\text{H}_2\text{O}$ .sat. solution in water contain 20.4 gms. salicylate at  $15^\circ$  (14.3 gms.  
Caines, 1905), and 79.7 gms. at  $100^\circ$ .

(Tarugi and Checchi, 1901.)

90% alcohol dissolve 0.6 gm. salicylate at  $15^\circ$ – $20^\circ$ . (Squire and Caines, 1905.)



# MAGNESIUM SILICATE 396

## MAGNESIUM SILICATE $\text{MgSiO}_3$ .

Fusion-point data for mixtures of  $\text{MgSiO}_3 + \text{MnSiO}_3$  are given by Le (1911). Results for  $\text{MgSiO}_3 + \text{Na}_2\text{SiO}_3$  are given by Wallace (1909).

## MAGNESIUM FLUOSILICATE $\text{MgSiF}_6 \cdot 6\text{H}_2\text{O}$ .

One liter of water dissolves 652 gms. of the salt at  $17.5^\circ$ . Sp. Gr. of so = 1.235. (Stolba)

## MAGNESIUM SUCCINATE $\text{C}_4\text{H}_4\text{O}_4\text{Mg} \cdot 5\text{H}_2\text{O}$ .

100 gms. sat. solution in water contain 24.35 gms. succinate at  $15^\circ$  and gms. at  $100^\circ$ . (Tarugi and Checchi)

## MAGNESIUM SULFATE $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ .

### SOLUBILITY IN WATER.

(Results by several investigators. 4th Ed. Landolt and Börnstein, "Tabel 1912.)

t°.	Gms. $\text{MgSO}_4$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{MgSO}_4$ per 100 Gms. Sat. Sol.	Solid Phase.
Unstable Portions of Curve.					
-2.9	13.9 (1)	Ice	-8.4	23.6 (1)	Ice
-3.9	19. (2)	" + $\text{MgSO}_4 \cdot 12\text{H}_2\text{O}$	-5	19 (12)	" + $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ rh
+1.8	21.1 (2)	$\text{MgSO}_4 \cdot 12\text{H}_2\text{O} + \text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	0	20.6 (3)	$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ rhomb
10	23.6 (3)	$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ (rhombic)	0	25.8 (3)	" $\beta$ hex
20	26.2 (3)	"	+10	27.9 (3)	" "
25	26.8 (4)	"	20	30 (3)	" "
30	29 (5)	"	0	29 (3)	$\text{MgSO}_4 \cdot 6\text{H}_2\text{O}$
40	31.3 (5)	"	10	29.7 (3)	"
48	33 (6)	" + $\text{MgSO}_4 \cdot 6\text{H}_2\text{O}$	20	30.8 (3)	"
50	33.5 (7)	$\text{MgSO}_4 \cdot 6\text{H}_2\text{O}$	30	31.2 (7)	"
55	34.3 (7)	"	70	37.3 (5)	"
60	35.5 (5)	"	80	39.1 (5)	"
68	37 (8)	" + $\text{MgSO}_4 \cdot \text{H}_2\text{O}$	90	40.8 (5)	"
80	38.6 (7)	$\text{MgSO}_4 \cdot \text{H}_2\text{O}$	100	42.5 (5)	"
83	40.2 (9)	"			
99.4	40.6 (10)	"			
104	29.3 (11)	"			
188	20.3 (11)	"			

(1) de Copnet, 1872; (2) Cottrell et al, 1901; (3) Loewel, 1855; (4) Basch, 1901; (5) (6) Van der Heide, 1893; (7) Smith, 1912; (8) Van't Hoff, 1901; (9) Geiger, 1904; (10) Mey 1912; (11) Etard, 1894; (12) Guthrie, 1876. See also Tilden, 1884.

Data for densities of aq.  $\text{MgSO}_4$  solutions are given by Barnes and Scott,

### SOLUBILITY OF MAGNESIUM SULFATE IN AQUEOUS SOLUTIONS OF POTASSIUM SULFATE AT $25^\circ$ AND VICE VERSA.

(Van Klooster, 1917.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase
$\text{MgSO}_4$ .	$\text{K}_2\text{SO}_4$ .		$\text{MgSO}_4$ .	$\text{K}_2\text{SO}_4$ .	
26.76	0	$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	13.26	10.34	$\text{MgK}_2(\text{SO}_4)_2$
26.67	1.68	"	12.88	10.51	"
26.57	2.34	"	12.68	10.70	" + $\text{K}_2\text{SO}_4$
26.36	3.76	"	12.06	10.77	$\text{K}_2\text{SO}_4$
26.39	4.02	" + $\text{MgK}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	10.69	10.84	"
18.76	7.02	$\text{MgK}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	7.8	11.10	"
16.36	8.43	"	4	11.03	"
14.27	9.63	"	0	10.77	"

100 gms. 95% formic acid dissolve 0.34 gm.  $\text{MgSO}_4$  at  $19^\circ$ . (Aachen.



**SOLUBILITY OF MAGNESIUM SULFATE IN METHYL AND ETHYL ALCOHOLS**  
(de Bruyn, 1892.)

Solvent.	t°.	Per 100 Gms. Solvent.	Solvent.	t°.	Per 100 Gms. Solvent.
ba. CH <sub>3</sub> OH	18	1.18 gms. MgSO <sub>4</sub>	93% Methyl Alc.	17	9.7 gms. MgSO <sub>4</sub> ·7H <sub>2</sub> O
"	17	4.1 " MgSO <sub>4</sub> ·7H <sub>2</sub> O	50% " "	3-4	4.1 " "
"	3-4	29 " "	Abs. C <sub>2</sub> H <sub>5</sub> OH	3	1.3 " "

**SOLUBILITY IN AQUEOUS ETHYL ALCOHOL.**  
(Schiff, 1861.)

Weight per cent Alcohol	10	20	40
Gms. MgSO <sub>4</sub> ·7H <sub>2</sub> O per 100 gms. solvent	64.7	27.1	1.65

**SOLUBILITY OF MAGNESIUM SULFATE IN SATURATED SUGAR SOLUTION AT 31.25°.**  
(Köhler, 1897.)

100 gms. saturated aqueous solution contain 46.52 gms sugar + 14 gms. MgSO<sub>4</sub>.

100 gms. water dissolve 119.6 gms. sugar + 36 gms. MgSO<sub>4</sub>.

Data for the system magnesium sulfate, phenol, and water are given by Timmermans, 1907.

Fusion-point data for mixtures of MgSO<sub>4</sub> + K<sub>2</sub>SO<sub>4</sub> are given by Ginsberg, 1906; Nacken, 1907a and Grahmann, 1913. Results for MgSO<sub>4</sub> + Na<sub>2</sub>SO<sub>4</sub> are given by Nacken 1907b.

**MAGNESIUM POTASSIUM SULFATE MgK<sub>2</sub>(SO<sub>4</sub>)<sub>2</sub>·6H<sub>2</sub>O.**

**SOLUBILITY IN WATER.**  
(Tobler, 1855.)

t° =	0°	20°	30°	45°	60°	75°
Gms. MgK <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> per 100 gms. H <sub>2</sub> O	14.1	25	30.4	40.5	50.2	59.8

100 gms. H<sub>2</sub>O dissolve 30.52 gms. MgK<sub>2</sub>(SO<sub>4</sub>)<sub>2</sub>·6H<sub>2</sub>O at 15°. (Lothian, 1909.)

**MAGNESIUM SULFITE MgSO<sub>3</sub>·6H<sub>2</sub>O.**

10 gms. cold water dissolve 1.25 gms. sulfite; 100 gms. boiling water dissolve 0.83 gm. (Hager, 1875.)

100 gms. H<sub>2</sub>O dissolve 1 gm. sulfite at 15°. (Squire and Caines, 1905.)

**MAGNESIUM SULFONATES.**

**SOLUBILITY IN WATER AT 20°.**  
(Sandquist, 1912.)

Compound.	Gms. Anhydrous Salt per 100 Gms. H <sub>2</sub> O.
Magnesium -2-Phenanthrene Monosulfonate 6H <sub>2</sub> O	0.051
" -3- " 4H <sub>2</sub> O	0.116
" -10- " 5H <sub>2</sub> O	0.22



**MALAMINIC ACID**

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 **$\beta$  MALAMINIC ACID**  $\text{CH}_2(\text{OH})\text{COOH} \cdot \text{CH}_2\text{CONH}_2, \text{CH}_2\text{COO} \cdot \text{NH}_2 \cdot \text{CHCOOH}$ 

SOLUBILITY IN WATER AT 18°. (Lutz, 1902.)

Compound.	M.-pt.	Gms. per 100 Gms. H <sub>2</sub> O.	( $\alpha$ ) <sub>D</sub> in Water C=1, t=2.
<i>d</i> $\beta$ Malaminic Acid	149	7.52	+9.70
<i>l</i> " "	149	7.50	-9.33
<i>r</i> " "	148	4.02	...

**MALEIC ACID**  $\text{COOHCH}::\text{CH} \cdot \text{COOH}$  (see also p. 304).

SOLUBILITY IN SEVERAL ALCOHOLS. (Timofeiew, 1894.)

Alcohol.	t°.	Gms. (CHCOOH) <sub>2</sub> per 100 Gms. Sat. Sol.	Alcohol.	t°.	Gms. (CHCOOH) <sub>2</sub> per 100 Gms. Sat. Sol.
Methyl Alcohol	22.5	41	Propyl Alcohol	0	20
Ethyl Alcohol	0	30.2	"	22.5	24.3
"	22.5	34.4	Isobutyl Alcohol	0	14.2
			"	22.5	17.5

Data for the distribution of maleic acid between ether and water at 25° given by Chandler, 1908.

Freezing-point data for mixtures of maleic acid and *l* mandelic acid are given by Centnerszwer, 1899.**MALIC ACID** *l*  $\text{COOH} \cdot \text{CH}_2\text{CHOHCOOH}$ .

100 gms. methyl alcohol dissolve 124.8	gms. malic acid at 0°.	(Timofeiew, 1894)
" " " " 167.7	" " " 19.1°	"
" ethyl " " 91.4	" " " 19°	"
" propyl " " 54	" " " 19°	"
" dichlorethylene " 0.009	" " " 15°	(Wester & Bruins, 1898)
" trichlorethylene " 0.010	" " " 15°	"

DISTRIBUTION OF MALIC ACID BETWEEN WATER AND ETHER. (Pinnow, 1915.)

Results at 15°.			Results at 25.5°.		
Gm. Mols. Acid per Liter:		Dist. Coeff.	Gm. Mols. Acid per Liter:		Dist. Coeff.
H <sub>2</sub> O Layer.	Ether Layer.		H <sub>2</sub> O Layer.	Ether Layer.	
0.564	0.0091	62	1.179	0.0172	68.4
0.288	0.0045	64	0.582	0.0082	71
0.151	0.0024	62.9	0.293	0.0040	73
0.067	0.0157	61.6	0.142	0.0020	71

Freezing-point data for *i* malic acid + *l* mandelic acid are given by Centnerszwer, 1899.**MALONIC ACID**  $\text{CH}_2(\text{COOH})_2$ .

SOLUBILITY IN WATER.

(Klobbie, 1897; Miczynski, 1886; Henry, 1884; Lamoureux, 1898, 1899.)

t°.	Gms. CH <sub>2</sub> (COOH) <sub>2</sub> per 100.		t°.	Gms. CH <sub>2</sub> (COOH) <sub>2</sub> per 100.	
	Gms. Solution.*	cc. Solution (L.).		Gms. Solution.*	cc. Solution (L.)
0	52	61	50	71	93
10	56.5	67	60	74.5	100
20	60.5	73	70	...	106
25	62.2	76.3	80	82	...
30	64	80	100	89	...
40	68	86.5	132 m. pt.	100	...

\* Average curve from results of K., M., and H.

100 gms. 95% formic acid dissolve 22.42 gms. malonic acid at 19.5°. (Aschan, 1911)



**SOLUBILITY OF MALONIC ACID IN ALCOHOLS.**  
(Timofeiew, 1894.)

Alcohol.	t°.	Gms. $\text{CH}_2(\text{COOH})_2$ per 100 Gms. Sat. Sol.	Alcohol.	t°.	Gms. $\text{CH}_2(\text{COOH})_2$ per 100 Gms. Sat. Sol.
thyl Alcohol	-18.5	42.7	Ethyl Alcohol	+19.5	41.3
" "	-15	43.5	Propyl Alcohol	-18.5	19.5
" "	0	47.3	" "	-15	20.2
" "	+19	52.5	" "	0	24.3
" "	+19.5	53.3	" "	+19	29.5
thyl Alcohol	-18.5	30	" "	+19.5	30.7
" "	-15	30.7	Isobutyl Alcohol	0	17.5
" "	0	35.3	" "	19	21.2
" "	+19	40.1			

**SOLUBILITY OF MALONIC ACID IN ETHER.**  
(Klobbie, 1897.)

t°.	Gms. $\text{CH}_2(\text{COOH})_2$ per 100 Gms. Solution.	t°.	Gms. $\text{CH}_2(\text{COOH})_2$ per 100 Gms. Solution.	t°.	Gms. $\text{CH}_2(\text{COOH})_2$ per 100 Gms. Solution.
0	6.25	30	10.5	100	46
10	7.74	80	33	110	56
20	9	90	39	120	70
25	9.7			132 m. pt.	100

100 gms. saturated solution of malonic acid in pyridine contain 14.6 gms. at 26°.  
(Holty, 1905.)

**SOLUBILITY OF SUBSTITUTED MALONIC ACIDS IN WATER.**  
(Lamoureux, 1899.)

Gms. per 100 cc. Saturated Aqueous Solution.						
t°.	Malonic Acid.	Methyl Malonic Acid.	Ethyl Malonic Acid.	n Propyl Malonic Acid.	n Butyl Malonic Acid.	Iso Amyl Malonic Acid.
0	61.1	44.3	52.8	45.6	11.6	38.5
15	70.2	58.5	63.6	60.1	30.4	51.8
25	76.3	67.9	71.2	70	43.8	79.3
30	92.6	91.5	90.8	94.4	79.3	83.4

**DISTRIBUTION OF MALONIC ACID BETWEEN ETHER AND WATER AT 25°.**  
(Chandler, 1908.)

Mols. Acid per Liter.		Coef.	Conc. H <sub>2</sub> O	Dist. Coef. corrected for ionization.
H <sub>2</sub> O Layer.	Ether Layer.		Conc. Ether	
0.1478	0.0135		10.94	9.86
0.1121	0.0102		11.07	9.79
0.0862	0.0076		11.28	9.86
0.0331	0.0027		12.22	9.82

**MALONIC ACID**  $\text{C}_6\text{H}_5\text{CH}(\text{OH})\text{COOH}$  *i* and *d*.

**SOLUBILITY IN SEVERAL SOLVENTS.**

Solvent.	t°.	Gms. $\text{C}_6\text{H}_5\text{CHOHCOOH}$ per 100 Gms. Sat. Sol.	Authority.
at 20	20	15.95 (inactive acid)	(Schlossberg, 1900.)
" "	20	19.17 (dextro acid)	"
Ethyl Alcohol	0	51.1 (inactive acid)	(Timofeiew, 1894.)
" "	16.5	64.9	"
Ethyl Alcohol	0	46.7	"
" "	16.5	53.6	"
Propyl Alcohol	0	35	"
" "	16.5	43	"
95% Formic Acid	19	40	(Aschan, 1913.)



# MANDELIC ACID

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FREEZING-POINT DATA (Solubility, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES OF MANDELIC ACID AND OTHER COMPOUNDS.

d	Mandelic Acid	+ l	Mandelic Acid	(Adriani, 1900—)			
i	"	+	"	(Centnerswer, 1899.)			
i	"	Methylester	+ l	Mandelic Methylester	"		
i	"	Isobutylester	+ l	Mandelic Isobutylester	"		
i	"	Acid	+ Dimethylpyrone	(Kendall, 1914—)			
l	"	l	Menthylester	+ d	Mandelic l	Menthylester	(Findlay and Hickmans, 1909.)

## Menthyl MANDELATES.

SOLUBILITY IN ETHYL ALCOHOL.  
(Findlay and Hickmans, 1909.)

Solvent.	t°.	Gms. per 100 Gms. Solvent.		Solid Phase.	Solvent.	t°.	Gms. per 100 Gms. Solvent.		Solid Phase.
		L.	D.				L.	D.	
80% Alcohol	35	...	1.08	D	80% Alcohol	10	...	0.287	D
"	35	3.19	...	L	"	10	0.595	...	L
"	35	0.80	0.80	R	"	10	0.184	0.184	R
"	35	0.544	1.35	D+R	"	10	0.404	0.201	D+R
"	35	2.83	0.60	L+R	"	10	0.505	0.088	L+R
"	25	...	0.595	D	Abs. Alcohol	0	...	1.00	D
"	25	1.64	...	L	"	0	1.93	...	L
"	25	0.448	0.448	R	"	0	0.625	0.625	R
"	25	0.321	0.882	D+R	"	0	0.535	0.915	D+R
"	25	1.192	0.267	L+R	"	0	1.03	0.54	L+R

\*  $d_{20} = 0.8517$ .

D = l menthyl d mandelate,  $[\alpha]_D^{17.5} = -9.45^\circ$  in alcohol.

L = l menthyl l mandelate  $[\alpha]_D^{20} = -140.92^\circ$  in alcohol.

R = l menthyl r-mandelate  $[\alpha]_D^{11.5} = -75.03$  in alcohol.

## MANGANESE BORATE $MnH_4(BO_3)_2$ .

SOLUBILITY IN WATER AND IN AQUEOUS SALT SOLUTION.

(Hartley and Ramage — J. Ch. Soc. 63, 137, '93.)

t°.	Grams $MnH_4(BO_3)_2$ per Liter in Solutions of:				
	$H_2O$ + trace $Na_2SO_4$ .	$Na_2SO_4$ (0.2 Gms. per Liter).	$Na_2SO_4$ (20 Gms. per Liter).	$NaCl$ (20 Gms. per Liter).	$CaCl_2$ (20 Gms. per Liter).
14	0.94	1.7	...	...	...
18	...	...	0.77	1.31	2.91
40	0.50	0.69 (52°)	0.65	...	2.44
60	...	...	0.36	0.60	2.25
80	0.08	...	0.12	0.29	1.35

## MANGANESE BROMIDE $MnBr_2$ .

SOLUBILITY IN WATER.

(Etard, 1894.)

t°.	Gms. $MnBr_2$ per 100 Gms. Solution.	Solid Phase.	t°.	Gms. $MnBr_2$ per 100 Gms. Solution.	Solid Phase.
-20	52.3	$MnBr_2 \cdot 4H_2O$	40	62.8	$MnBr_2$
-10	54.2	"	50	64.5	"
0	56.0	"	60	66.3	"
10	57.6	"	70	68.0	"
20	59.5	"	80	69.2	$MnBr_2$
25	60.2	"	90	69.3	"
30	61.1	"	100	69.5	"



**THE CARBONATE**  $\text{MnCO}_3$ .

water dissolves  $5.659 \cdot 10^{-4}$  mols.  $\text{MnCO}_3 = 0.065$  gm. at  $25^\circ$ .  
(Agazo and Valla, 1911.)

**THE CHLORIDE**  $\text{MnCl}_2$ .

## SOLUBILITY IN WATER.

(Etard; Dawson and Williams — Z. physik. Chem. 31, 63, '99.)

Sp. Gr. of Solutions.	Grams $\text{MnCl}_2$ per 100 Grams Water.	Solution.	Mols. $\text{MnCl}_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
...	53.8	35.0	...	$\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$
...	58.7	37.0	...	"
...	63.4	38.8	...	"
...	68.1	40.5	...	"
...	73.9	42.5	...	"
1.4991	77.18	43.55	11.08	"
1.5049	80.71	44.68	11.55	"
1.5348	88.59	46.96	12.69	"
1.5744	98.15	49.53	14.05	"
1.6097	105.4	51.33	15.10	"
1.6108	108.6	52.06	15.55	$\text{MnCl}_2 \cdot 2\text{H}_2\text{O}$
1.6134	110.6	52.52	15.85	"
...	112.7	52.98	16.14	"
...	114.1	53.2	...	"
...	115.3	53.5	...	"
...	118.8	54.3	...	"
...	119.5	55.0	...	"

of water dissolves 87.0 grams  $\text{MnCl}_2$ . One liter of sat.  $\text{HCl}$  9.0 grams  $\text{MnCl}_2$  at  $12^\circ$ .  
(Ditte — Compt. rend. 92, 248, '81.)

**JM IN THE SYSTEM MANGANESE CHLORIDE, POTASSIUM CHLORIDE AND WATER.** (Süss, 1913.)

100 Gms. Sol.	Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
KCl.				
...	$\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$	52.8	50.14	6.01 $\text{MnCl}_2 \cdot 4\text{H}_2\text{O} + \text{MnCl}_2 \cdot 2\text{H}_2\text{O} + 1.1.2$
9.41	" + 1.1.2 + KCl	58.3	51.72	...
23.06	KCl	62.6	51.86	...
...	$\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$	62.6	49.95	6.67 $\text{MnCl}_2 \cdot 2\text{H}_2\text{O}$
8.66	" + 1.1.2	62.6	44.05	12.49 $1.1.2 + \text{MnCl}_2 \cdot 2\text{H}_2\text{O}$
13.79	" + 1.2.2 + KCl	62.6	36.85	18.77 $\text{MnCl}_2 \cdot 2\text{H}_2\text{O} + \text{MnCl}_2 \cdot 4\text{H}_2\text{O}$
26.91	KCl	62.6	31.57	KCl

1.1.2 =  $\text{MnCl}_2 \cdot \text{KCl} \cdot 2\text{H}_2\text{O}$ . 1.2.2 =  $\text{MnCl}_2 \cdot 2\text{KCl} \cdot 2\text{H}_2\text{O}$

hydrous hydrazine dissolve 13 gms.  $\text{MnCl}_2$  at room temp.

int data for  $\text{MnCl}_2 + \text{SnCl}_2$  (Sandonnini, 1911),  $\text{MnCl}_2 + \text{SnCl}_2$  and Scarpa, 1911),  $\text{MnCl}_2 + \text{ZnCl}_2$  (Sandonnini, 1912 and 1914).  
(Welsh and Broderson, 1915.)

**THE CINNAMATE**  $(\text{C}_6\text{H}_5\text{CH}:\text{CHCOO})_2\text{Mn}$ .

$\text{H}_2\text{O}$  dissolve 0.26 gm. manganese cinnamate at  $26^\circ$ . (De Jong, 1909.)

**THE FLUOSILICATE**  $\text{MnSiF}_6 \cdot 6\text{H}_2\text{O}$ .

$\text{H}_2\text{O}$  dissolve 140 gms. salt at  $17.5^\circ$ . Sp. Gr. of solution = 1.448.  
(Stolba, 1883.)

**THE HYDROXIDE**  $\text{Mn}(\text{OH})_2$ .

$\text{H}_2\text{O}$  dissolves  $2.15 \cdot 10^{-4}$  gms. mols.  $\text{Mn}(\text{OH})_2$  at  $18^\circ$ .

(Sackur and Fritzmann, 1909.)

$\text{H}_2\text{O}$  dissolves  $2.10 \cdot 10^{-4}$  gms. mols.  $\text{Mn}(\text{OH})_2$  at  $18^\circ$ . (Tamm, 1910.)

mination of S. & F. was made by the neutralization method of Kuster, determining the conductivity minimum on adding  $\text{Ba}(\text{OH})_2$  to  $\text{MnSO}_4$  | calculating the  $\text{Mn}(\text{OH})_2$  remaining in solution.



## MANGANESE HYDROXIDE 402

### SOLUBILITY OF MANGANESE HYDROXIDE IN AQUEOUS SOLUTIONS OF ORGANIC SALTS. (Tamm, 1910.)

(25 cc. of the neutral salt solution + 25 cc. of aqueous suspension of Mn(OH)<sub>2</sub> were shaken different lengths of time. Temp. not stated.)

100 cc. sat. solution in 1 N sodium tartrate solution contain 0.052 gm. Mn

100 cc. sat. solution in 1 N sodium malate solution contain 0.032 gm. Mn

100 cc. sat. solution in 1 N sodium citrate solution contain 0.095 gm. Mn

### MANGANESE IODOMERCURATE 3MnI<sub>2</sub>·5HgI<sub>2</sub>·20H<sub>2</sub>O.

A saturated solution of the salt in water at 17° has the composition 1.4 MnI<sub>2</sub>·HgI<sub>2</sub>·10.22H<sub>2</sub>O and density 2.98. (Dubow, 1906.)

### MANGANESE NITRATE Mn(NO<sub>3</sub>)<sub>2</sub>.

#### SOLUBILITY IN WATER.

(Funk — Wiss. Abh. p. t. Reichanstalt 3, 438, '00.)

t.°.	Gms. Mn(NO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Sol.	Mols. Mn(NO <sub>3</sub> ) <sub>2</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.	t.°.	Gms. Mn(NO <sub>3</sub> ) <sub>2</sub> per 100 Gms. Sol.	Mols. Mn(NO <sub>3</sub> ) <sub>2</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.
-29	42.29	7.37	Mn(NO <sub>3</sub> ) <sub>2</sub> ·6H <sub>2</sub> O.	18	57.33	13.5	Mn(NO <sub>3</sub> ) <sub>2</sub> ·6H <sub>2</sub> O.
-26	43.15	7.63	"	25	62.37	16.7	"
-21	44.30	8.0	"	27	65.66	19.2	Mn(NO <sub>3</sub> ) <sub>2</sub> ·3H <sub>2</sub> O.
-16	45.52	8.4	"	29	66.99	20.4	"
-5	48.88	9.61	"	30	67.38	20.7	"
0	50.49	10.2	"	34	71.31	24.9	"
+11	54.50	12.0	"	35.5	76.82	33.3	"

Sp. Gr. of solution saturated at 18° = 1.624.

The Eutec is at -36° and 40.5 gms. Mn(NO<sub>3</sub>)<sub>2</sub> per 100 gms. Sat. Sol.

### MANGANESE OXALATE MnC<sub>2</sub>O<sub>4</sub>·2H<sub>2</sub>O.

#### SOLUBILITY IN AQUEOUS SOLUTIONS AT 25°.

(Hauser and Wirth, 1909.)

In Oxalic Acid Solutions.		In Ammonium Oxalate Solutions.		In Sulfuric Acid Solutions.		Solid Phase.
Per 1000 Gms. Sat. Sol.	Gms. Mn(COO) <sub>2</sub> ·(COOH) <sub>2</sub> .	Per 1000 Gms. Sat. Sol.	Gms. Mn(COO) <sub>2</sub> ·(NH <sub>4</sub> ) <sub>2</sub> (COO) <sub>2</sub> .	Per 1000 Gms. Sat. Sol.	Gms. Mn(COO) <sub>2</sub> ·H <sub>2</sub> SO <sub>4</sub> .	
0	0.312	0.005	0.338	0.025	1.825	MnC <sub>2</sub> O <sub>4</sub> ·2H <sub>2</sub> O
0.0125	0.759	0.025	0.479	0.24	8.850	"
0.025	0.930	0.050	0.761	1	25.955	"
0.050	1.080	0.125	1.789	2.389	51.080	"
0.125	1.396	0.245	3.970	2.987	60.100	MnC <sub>2</sub> O <sub>4</sub> ·2H <sub>2</sub> O + (COOH) <sub>2</sub>
0.25	1.708	0.245	4.005	3.952	73.200	"
0.49	2.081	0.281	4.650	4.500	82.401	"

Results are also given for the solubility of MnC<sub>2</sub>O<sub>4</sub>·2H<sub>2</sub>O in aq. solutions of H<sub>2</sub>SO<sub>4</sub> containing also about 0.25 gm. mols. free oxalic acid per liter at 25°

### MANGANESE OXIDE MnO.

Fusion-point data for mixtures of manganese oxide and silicic acid are given by Doernickel, 1907.

### MANGANESE (Hypo) PHOSPHITE Mn(PH<sub>2</sub>O<sub>2</sub>)<sub>2</sub>·H<sub>2</sub>O.

100 gms. H<sub>2</sub>O dissolve 15.15 gms. salt at 25°, and 16.6 gms. at b. pt. (U. S. P.)

### MANGANESE SILICATE MnSiO<sub>3</sub>.

Fusion-point data for mixtures of manganese silicate and titanate are given by Smolensky, 1911-12.



MANGANESE SULFATE  $\text{MnSO}_4$ .

## SOLUBILITY IN WATER.

Notes. — J. Physic. Ch. 4, 651, '01; Richards and Fraprie — Am. Ch. J. 26, 77, '01. The results of Jacobberger — Am. Ch. J. 15, 225, '93, were shown to be incorrect by Cottrell, and this conclusion confirmed by R. and F.)

t°.	Grams $\text{MnSO}_4$ per 100 Gms.		Solid Phase.	t°.	Grams $\text{MnSO}_4$ per 100 Gms.		Solid Phase
	Water.	Solution.			Water.	Solution.	
-10	47.96	32.40	$\text{MnSO}_4 \cdot 7\text{H}_2\text{O}$	16	63.94	38.99	$\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$
0	53.23	34.73	"	18.5	64.19	39.10	"
5	56.24	35.99	"	25	65.32	39.53	"
9	59.33	37.24	"	30	66.44	39.93	"
12	61.77	38.19	"	39.9	68.81	40.77	"
14.3	63.93	39.00	"	49.9	72.63	42.08	"
5	58.06	36.69	$\text{MnSO}_4 \cdot 5\text{H}_2\text{O}$	41.4	60.87	37.84	$\text{MnSO}_4 \cdot \text{H}_2\text{O}$
9	59.19	37.18	"	50	58.17	36.76	"
15	61.08	37.91	"	60	55.0	35.49	"
25	64.78	39.31	"	70	52.0	34.22	"
30	67.76	40.38	"	80	48.0	32.43	"
35-5	71.61	41.74	"	90	42.5	29.83	"
				100	34.0	24.24	"

STABILITY OF MANGANESE SULFATE, COPPER SULFATE MIXED CRYSTALS  
IN WATER AT 18°.  
(Stortenbecker, 1900.)

Mols. per 100 $\text{H}_2\text{O}$ .	Mol. per cent Cu in:		Mols. per 100 $\text{H}_2\text{O}$ .	Mol. per cent Cu in:	
	Cu.	Mn.		Cu.	Mn.
Solid Phase. $\text{CuMnSO}_4 \cdot 5\text{H}_2\text{O}$ , Triclinic.			Solid Phase. $\text{CuMnSO}_4 \cdot 5\text{H}_2\text{O}$ , Triclinic.		
2.282	0	100	[0.73	6.37	10.27
...	...	90.5	...	...	5.0
2.23	0.44	83.5	0.34	7.03	4.60
...	...	74.1	...	...	2.31
...	...	57.7	...	7.375	0.0
...	...	31.0	Solid Phase. $\text{CuMnSO}_4$ , Monoclinic. $7\text{H}_2\text{O}$ .		
1.54	3.76	29.0	...	...	20.4
...	...	26.1	...	...	28.2*
1.31	4.70	21.8	[1.06	5.58	15.9
...	...	21.2	...	...	12.45
...	...	20.0	[0.73	6.37	10.27
[1.06	5.58	15.9	...	...	4.60
...	...	13.9	...	±8	0.0

\* Indicates meta stabil points.

$\text{CuMnSO}_4 \cdot 5\text{H}_2\text{O}$  = 100-90.8 and 2.11-0 mol. per cent Cu.

$\text{CuMnSO}_4 \cdot 7\text{H}_2\text{O}$  = 37.8-4.92 mol. per cent Cu.

## SOLUBILITY OF MANGANESE SULFATE IN GLYCOL.

100 gms. saturated solution contain 0.5 gm.  $\text{MnSO}_4$ .

(de Coninck, 1905.)



SOLUBILITY OF MANGANESE SULFATE IN AQUEOUS SOLUTIONS OF  
AMMONIUM SULFATE AT 25° AND 50° AND VICE VERSA.

(Schreinemakers, 1909.)

## Results at 25°.

Gms. per 100 Gms. Sat. Sol.	Gms.	Solid Phase.
$\text{MnSO}_4$	$(\text{NH}_4)_2\text{SO}_4$	
39.3	0	$\text{MnSO}_4 \cdot 5\text{H}_2\text{O}$
38.49	3.64	" + $\text{D}_1$
33.44	4.91	$\text{D}_1$
22.06	9.65	"
9.02	20.36	"
2.91	37.42	"
1.75	42.58	" + $(\text{NH}_4)_2\text{SO}_4$
1.77	43.24	$(\text{NH}_4)_2\text{SO}_4$
0	43.4	"

$\text{D}_1 = \text{MnSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ .

## Results at 50°.

Gms. per 100 Gms. Sat. Sol.	Gms.	Solid Phase.
$\text{MnSO}_4$	$(\text{NH}_4)_2\text{SO}_4$	
36.26	0	$\text{MnSO}_4 \cdot \text{H}_2\text{O}$
35.35	2.95	" + $\text{I}$
30.57	5.14	$\text{D}_{2-1}$
16.86	17.62	"
6.92	35.98	"
6.29	39.71	"
5.70	43.24	" + $(\text{NH}_4)_2\text{SO}_4$
3.49	44.02	$(\text{NH}_4)_2\text{SO}_4$
0	45.7	"

$\text{D}_{2-1} = (\text{MnSO}_4)_2(\text{NH}_4)_2\text{SO}_4$ .

SOLUBILITY OF MANGANESE SULFATE IN AQUEOUS SOLUTIONS OF SODIUM  
SULFATE AT 35° AND VICE VERSA.

(Schreinemakers and Provije, 1913.)

Gms. per 100 Gms. Sat. Sol.	Gms.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	Gms.	Solid Phase.
$\text{MnSO}_4$	$\text{Na}_2\text{SO}_4$		$\text{MnSO}_4$	$\text{Na}_2\text{SO}_4$	
39.45	0	$\text{MnSO}_4 \cdot \text{H}_2\text{O}$	13.96	21.91	$(\text{MnSO}_4)_2(\text{Na}_2\text{SO}_4)_2$ + $\text{MnSO}_4(\text{Na}_2\text{SO}_4)$
33.92	5.23	"	12.19	22.49	$\text{MnSO}_4(\text{Na}_2\text{SO}_4)$
33.06	7.97	" + $(\text{MnSO}_4)_2(\text{Na}_2\text{SO}_4)_2$	10.45	23.41	"
32.92	7.42	"	7.43	26.58	"
31.05	9.20	$(\text{MnSO}_4)_2(\text{Na}_2\text{SO}_4)_2$	5.69	29.31	"
27.67	10.76	"	5.11	30.52	" + $\text{Na}_2\text{S}$
22.14	14.28	"	2.96	31.33	"
14.58	20.01	"	0	33	"

Data for the solubility of mix crystals of manganese and zinc sulfates between 0° and 39° are given by Sahmen, 1905-06.

SOLUBILITY OF MANGANESE SULFATE IN AQUEOUS ETHYL ALCOHOL.

(Schreinemakers, 1909; Schreinemakers and Deuse, 1912.)

## Results at 25°.

Gms. per 100 Gms. Sat. Sol.	Gms.	Solid Phase.
$\text{C}_2\text{H}_5\text{OH}$	$\text{MnSO}_4$	
0	39.3	$\text{MnSO}_4 \cdot 5\text{H}_2\text{O}$
6.81	33.72	"
liquid layers separate here		
53.09	1.23	"
57.39	0.56	"
76.70	0	$\text{MnSO}_4 \cdot \text{H}_2\text{O}$

## Results at 50°.

Gms. per 100 Gms. Sat. Sol.	Gms.	Solid Phase.
$\text{C}_2\text{H}_5\text{OH}$	$\text{MnSO}_4$	
0	36.26	$\text{MnSO}_4 \cdot \text{H}_2\text{O}$
6.67	28.12	"
16.02	18.75	"
22.63	12.54	"
36.47	4.12	"

## Composition of the liquid layers.

Water rich Layer.		$\text{C}_2\text{H}_5\text{OH}$ rich Layer.	
% $\text{C}_2\text{H}_5\text{OH}$ .	% $\text{MnSO}_4$ .	% $\text{C}_2\text{H}_5\text{OH}$ .	% $\text{MnSO}_4$ .
6.81	33.72*	53.09	1.23*
8.48	31.51	49.76	1.83
15.02	22.61	32.75	8.01

The following reciprocally saturated stable solutions were obtained at 50°

Water rich Layer.		$\text{C}_2\text{H}_5\text{OH}$ rich Layer.	
% $\text{C}_2\text{H}_5\text{OH}$ .	% $\text{MnSO}_4$ .	% $\text{C}_2\text{H}_5\text{OH}$ .	% $\text{MnSO}_4$ .
5.68	34.95	53.64	0.9
7.69	30.99	45.83	2.1
8.70	29.20	41.93	3.1
11.85	24.84	35.15	5.5

\* These liquids in contact with  $\text{MnSO}_4 \cdot 5\text{H}_2\text{O}$ .

Similar data are also given for 30° and for 35°. Both stable and metastable liquid pairs were obtained at these intermediate temperatures.

Additional data for this system are also given by Cuno, 1908.



## SOLUBILITY OF MANGANESE SULFATE IN AQUEOUS ETHYL ALCOHOL (CONC.).

Composition of the conjugated liquids in contact with excess of solid salt.

t°.	C <sub>2</sub> H <sub>5</sub> OH rich Layer.		Aqueous rich Layer.		Solid Phase.
	% C <sub>2</sub> H <sub>5</sub> OH	% MnSO <sub>4</sub>	% C <sub>2</sub> H <sub>5</sub> OH	% MnSO <sub>4</sub>	
10	37.06	5.44	13.78	25.25	MnSO <sub>4</sub> ·5H <sub>2</sub> O
15	44.56	2.79	9.25	29.79	"
17.	47.11	2.22	8.53	30.88	"
21	53.55	1.30	6.10	35.05	"
25	53.09	1.23	6.81	33.72	"
30	45.20	2.49	8.69	30.15	MnSO <sub>4</sub> ·H <sub>2</sub> O
31	43.90	2.74	8.47	30.10	"
35	41.71	3.44	9.24	28.61	"
37	38.26	4.84	11.03	26.47	"
41	34.01	5.86	11.03	24.97	"
42	32.37	6.89	13.57	23.09	"
43	31.42	8.51	14.33	22.01	"

Data for the solubility of manganese sulfate and potassium iodate in methyl alcohol are given by Karplus, 1907.

## SOLUBILITY OF MANGANESE SULFATE IN AQUEOUS ETHYL AND PROPYL ALCOHOL SOLUTIONS AT 20°.

(Lincoyner, 1892; Small, 1898.)

Conc. of Alcohol in Wt. per cent.	Gms. MnSO <sub>4</sub> per 100 Gms. Alc.		Conc. of Alcohol in Wt. per cent.	Gms. MnSO <sub>4</sub> per 100 Gms. Alc.	
	Ethyl Alc.	Propyl Alc.		Ethyl Alc.	Propyl Alc.
34	9.5	6	44	3.3	1.9
36	7.2	4.6	48	2.2	1.4
38	5.8	3.5	52	1.4	1.1
40	4.7	2.8			

100 cc. anhydrous hydrazine dissolve about 1 gm. MnSO<sub>4</sub> at room temp.

(Welsh and Broderick, 1915.)

Fusion-point data for mixtures of MnSO<sub>4</sub> + K<sub>2</sub>SO<sub>4</sub>, and MnSO<sub>4</sub> + Na<sub>2</sub>SO<sub>4</sub> are given by Calcagni and Marotta, 1914.

## MANGANESE SULFIDE MnS.

One liter sat. solution in water contains  $71.6 \cdot 10^{-6}$  mols. MnS = 0.00623 gm. per liter at 18° by conductivity method. (Weigel, 1907; see also Bruner and Zawadzki, 1909.)MANGANESE Potassium VANADATE MnKV<sub>3</sub>O<sub>14</sub>·8H<sub>2</sub>O.100 gms. H<sub>2</sub>O dissolve 1.7 gms. salt at 18°.

(Radon, 1889.)

MANNITOL CH<sub>2</sub>OH(CHOH)<sub>4</sub>CH<sub>2</sub>OH.

## SOLUBILITY IN WATER.

(Findlay, 1902.)

t°.	Gms. CH <sub>2</sub> OH(CHOH) <sub>4</sub> CH <sub>2</sub> OH per 100 Gms. H <sub>2</sub> O.	t°.	Gms. CH <sub>2</sub> OH(CHOH) <sub>4</sub> CH <sub>2</sub> OH per 100 Gms. H <sub>2</sub> O.
0	7.59	40	35.4
10	11.63 (13.94 gms. Campetti, 1901)	50.8	46.69
20	17.71 (18.98 gms. Campetti, 1901)	60	60.01
24.5	20.96	70	74.5
30	25.4	80	91.5
35.8	29.93	100	133.1

100 gms. alcohol, Sp. Gr. 0.905, dissolve 1.56 gms. mannitol at 14°. (Krusemann, 1876.)

Data for the solubility of mannitol at high pressures are given by Cohen, Bouye and Euwen, 1910.

100 gms. sat. sol. in pyridine contain 0.47 gm. mannitol at 26°. (Holty, 1905.)

100 gms. aq. 50% pyridine dissolve 2.46 gms. mannitol at 20-25°. (Dehn, 1917.)

Data for the ternary systems mannitol + succinic acid nitrile + water and mannitol + triethylamine + water, are given by Timmermans, 1907.



# MERCURY ACETATE

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## MERCURY ACETATE (ic) $\text{Hg}(\text{C}_2\text{H}_3\text{O}_2)_2$ , (ous) $\text{Hg}_2(\text{C}_2\text{H}_3\text{O}_2)_2$

100 gms. water dissolve 25 gms. mercuric acetate at  $10^\circ$ .  
 100 gms. water dissolve 0.75 gm. mercurous acetate at  $13^\circ$ .  
 100 cc. anhydrous hydrazine dissolve about 2 gms. mercurous acetate at temp. with precipitation of Hg. (Welsh and Broderick)

## MERCURY BENZOATE (ic) $(\text{C}_6\text{H}_5\text{COO})_2\text{Hg} \cdot \frac{1}{2}\text{H}_2\text{O}$

100 gms.  $\text{H}_2\text{O}$  dissolve 1.2 gms. mercuric benzoate at  $15^\circ$  and 2.5 gms. at  $25^\circ$ . (Tarugi and Checchi)

## MERCURY BROMIDE (ic) $\text{HgBr}_2$

### SOLUBILITY IN WATER.

t°.	Gms. $\text{HgBr}_2$ per 100 Gms. $\text{H}_2\text{O}$ .	Authority.
9	1.06	(Lassaigne, 1876.)
25	0.61	(Sherrill, 1903.)
100	20-25	(Lassaigne.)

Mercurous bromide. One liter sat. aq. solution contains 0.000039 gm. at  $25^\circ$ . (Sherrill)

### EQUILIBRIUM IN THE SYSTEM MERCURIC BROMIDE, AMMONIA, WATER AT $25^\circ$ (Gaudechon, 1910.)

The mixtures were shaken intermittently for 21-48 hrs. Both the solution and the separated and dried solid phases were analyzed.

Initial Mixture. Gms. Mols. per Liter.			Sat. Solution. Gms. Atoms. per Liter.			Solid Phase.
$\text{HgBr}_2$	$\text{NH}_3$	$\text{NH}_4\text{Br}$	Hg.	Br.	N.	
0.0125	0.0250	0	trace	0.0154	0.0185	$(\text{NH}_4\text{Br})_2\text{HgBr}_2$
0.0166	0.0332	0	0.00032	0.0172	0.0202	36% " +64% $\text{NH}_4\text{Br}$
0.025	0.050	0	0.00078	0.0241	0.0251	$\text{NH}_4\text{Br} \cdot 3\text{NH}_4\text{Br}$
0.050	0.100	0	0.0019	0.0525	0.0514	"
0.0125	0.025	0.0375	0.00178	0.0497	0.0497	"
0.025	0.050	0.075	0.0041	0.103	0.108	"
0.0328	0.0656	0.0984	0.0061	0.133	0.133	93% " +6% $\text{NH}_4\text{Br}$
0.0365	0.073	0.1095	0.0060	0.132	0.133	36% " +64% $\text{NH}_4\text{Br}$
0.050	0.100	0.150	0.007	0.170	0.169	$\text{NH}_4\text{Br} \cdot 3\text{NH}_4\text{Br}$
0.100	0.200	0.300	0.0124	0.333	0.338	"
0.0180	0.036	0.01875	0.001	0.0315	0.0318	$\text{NH}_4\text{Br} \cdot \text{NH}_4\text{Br}$
0.050	0.100	0.006	0.0057	0.1172	0.1178	"
0.050	0.100	0.150	0.0071	0.169	0.168	$\text{NH}_4\text{Br} \cdot 3\text{NH}_4\text{Br}$
0.100	0.200	0.160	0.0083	0.184	0.187	"
0.125	0.250	0.306	0.0160	0.393	...	"

### SOLUBILITY OF MERCURIC BROMIDE IN AQUEOUS SALT SOLUTIONS AT $25^\circ$ (Herz and Paul, 1913.)

(The mixtures were constantly agitated for eight days.)

In Aq. $\text{BaBr}_2$ . Mols. per Liter.		In Aq. $\text{CaBr}_2$ . Mols. per Liter.		In Aq. $\text{KBr}$ . Mols. per Liter.		In Aq. $\text{NaBr}$ . Mols. per Liter.		In Aq. $\text{SrBr}_2$ . Mols. per Liter.
$\text{BaBr}_2$	$\text{HgBr}_2$	$\text{CaBr}_2$	$\text{HgBr}_2$	$\text{KBr}$	$\text{HgBr}_2$	$\text{NaBr}$	$\text{HgBr}_2$	$\text{SrBr}_2$
0	0.017	0.072	0.117	0	0.017	0.118	0.078	0.062
0.274	0.370	0.645	0.676	0.209	0.098	0.596	0.285	0.328
0.396	0.540	1.892	1.358	0.770	0.472	1.142	0.540	0.668
0.579	0.759	2.479	2.766	2.380	1.360	2.448	1.276	1.401
1.096	1.478	3.754	3.666	3.470	1.930	5.246	2.306	1.872

The following slightly higher results for  $\text{KBr}$  solutions are given by (1903).

Mols. $\text{KBr}$ per liter	0	0.05	0.10	0.5	0.866	2	3
Mols. $\text{HgBr}_2$ per liter	0.017	0.055	0.088	0.0359	0.611	1.407	2.097

Data for equilibrium in the system  $\text{HgBr}_2 + \text{KOH} + \text{H}_2\text{O}$  at  $25^\circ$  are given by Herz (1910).



SOLUBILITY OF MERCURIC BROMIDE IN AQUEOUS SOLUTIONS OF METHYL  
 ALCOHOL, ETHYL ALCOHOL AND OF ETHYL ACETATE AT 25°.

(Herz and Anders, 1907.)

Aq. Methyl Alcohol.			In Aq. Ethyl Alcohol.			In Aq. Ethyl Acetate.		
% OH in re- sult.	$d_{25}^4$ of Sat. Sol.	Gms. HgBr <sub>2</sub> per 100 cc. Sat. Sol.	Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	$d_{25}^4$ of Sat. Sol.	Gms. HgBr <sub>2</sub> per 100 cc. Sat. Sol.	Wt. % CH <sub>3</sub> CO <sub>2</sub> C <sub>2</sub> H <sub>5</sub> in Solvent.	$d_{25}^4$ of Sat. Sol.	Gms. HgBr <sub>2</sub> per 100 cc. Sat. Sol.
1.6	0.9857	0.72	0	1.0022	0.60	0	1.0022	0.60
1.77	0.9588	1.29	20.18	0.9717	0.67	4.39	1.0018	0.574
1.06	0.9401	2.52	40.69	0.9435	1.59	96.76	1.1159	26.69
1	0.9386	6.85	70.01	0.9214	6.58	100	1.0113	14.13
1.05	0.9744	14.66	100	0.9873	22.81			
1	1.2275	50.25						

10 gms. sat. sol. in 95% C<sub>2</sub>H<sub>5</sub>OH ( $d_{15}^4 = 0.8126$ ) contain 13.2 gms. HgBr<sub>2</sub> at  
 6.53 gms. at 25° and 22.63 gms. at 50°. (Reinders, 1900.)

SOLUBILITY OF MERCURIC BROMIDE IN ALCOHOLS.

(Timofeiew, 1894.)

Methyl Alcohol.		In Ethyl Alcohol.		In Propyl Alcohol.		In Isobutyl Alcohol.	
Gms. HgBr <sub>2</sub> per 100 Gms. CH <sub>3</sub> OH.	t°.	Gms. HgBr <sub>2</sub> per 100 Gms. C <sub>2</sub> H <sub>5</sub> OH.	t°.	Gms. HgBr <sub>2</sub> per 100 Gms. C <sub>3</sub> H <sub>7</sub> OH.	t°.	Gms. HgBr <sub>2</sub> per 100 Gms. C <sub>4</sub> H <sub>9</sub> OH.	t°.
41.15	0	25.2	0	14.6	0	4.61	
49.5	10	26.3	10	15.6	10	5.63	
66.3	19	29.7	19	15.5	23	6.65	
60.9	39	31.9	39	20.8	39	9.58	
71.3	65	44.5	65	31.3	65	15.80	
90.8	89	66.9	86.5	42.7			

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SOLUBILITY OF MERCURIC BROMIDE IN MIXTURES OF ALCOHOLS AT 25°.

(Herz and Kuhn, 1908.)

Mixtures of Methyl and Ethyl Alcohols.			In Mixtures of Methyl and Propyl Alcohols.			In Mixtures of Ethyl and Propyl Alcohols.		
% OH in re- sult.	$d_{25}^4$ of Sat. Sol.	Gms. HgBr <sub>2</sub> per 100 cc. Sat. Sol.	% C <sub>2</sub> H <sub>5</sub> OH in Mixture.	$d_{25}^4$ of Sat. Sol.	Gms. HgBr <sub>2</sub> per 100 cc. Sat. Sol.	% C <sub>2</sub> H <sub>5</sub> OH in Mixture.	$d_{25}^4$ of Sat. Sol.	Gms. HgBr <sub>2</sub> per 100 cc. Sat. Sol.
1.6	0.9873	22.8	0	1.227	50.20	0	0.9873	22.80
1.77	0.9932	23.1	11.11	1.1954	47.28	8.1	0.9802	22.25
1.06	1.009	25.4	23.8	1.1524	41.53	17.85	0.9740	21.06
1	1.080	33.3	65.2	1.0257	25.30	56.6	0.9487	17.63
1	1.185	45.7	91.8	0.9437	16.35	88.6	0.9269	14.76
1	1.193	46.8	93.75	0.9368	15.86	91.2	0.9239	14.64
1	1.211	48.6	96.6	0.9275	14.66	95.2	0.9227	14.06
1	1.227	50.2	100	0.9213	13.78	100	0.9213	13.78

SOLUBILITY OF MERCURIC BROMIDE IN ORGANIC SOLVENTS.

In Carbon Disulfide.

(Arctowski, 1894.)

In Other Solvents at 18°-20°.

(Sulc., 1900.)

Gms. HgBr <sub>2</sub> per 100 Gms. Solution.	t°.	Gms. HgBr <sub>2</sub> per 100 Gms. Solution.	Solvent.	Formula.	Gms. HgBr <sub>2</sub> per 100 Gms. Solvent.
1	0.049	15	Chloroform	CHCl <sub>3</sub>	0.126
5	0.068	20	Bromoform	CHBr <sub>3</sub>	0.679
10	0.087	25	Carbon Tetrachloride	CCl <sub>4</sub>	0.003
5	0.105	30	Ethyl Bromide	C <sub>2</sub> H <sub>5</sub> Br	2.31
10	0.122		Ethylene Dibromide	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	2.34

Benzene dissolves 6.99 gms. HgBr<sub>2</sub> at 25°. (Abegg and Sherrill, 1903.)



SOLUBILITY OF MERCURIC BROMIDE IN AN EQUIMOLECULAR MIXTURE  
ETHYL ALCOHOL AND BENZENE. (Dukelski, 1907.)

t°.	0.	10.	20.	30.	40.	50.
Gms. HgBr <sub>2</sub> per 100 Gms. Sat. Sol.	10.7	12	14	16	17.5	19

100 gms. of sat. sol. in acetone at 25° contain 34.76 gms. HgBr<sub>2</sub>. (Reinders, 18)

## SOLUBILITY OF MERCURIC BROMIDE IN ANILINE. (Staronka, 1910.)

t°.	Mol. % HgBr <sub>2</sub> .	Gms. HgBr <sub>2</sub> per 100 Gms. C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> .	Solid Phase.	t°.	Mol. % HgBr <sub>2</sub> .	Gms. HgBr <sub>2</sub> per 100 Gms. C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub> .	Solid Phase.
60	4	16.14	HgBr <sub>2</sub> ·2C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub>	110*	33.3	193.3	HgBr <sub>2</sub> ·2C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub>
70	5.8	23.83	"	109.7†	33.5	195	" + HgBr <sub>2</sub> ·C <sub>6</sub> H <sub>5</sub> N
80	8.3	35.04	"	115	37.2	229.3	HgBr <sub>2</sub> ·C <sub>6</sub> H <sub>5</sub> NH <sub>2</sub>
90	12.2	53.80	"	120	42.3	283.8	"
100	18.8	89.64	"	124	50	387.2	"
105	23.2	116.9	"	123	55.4	480.9	"

\* M. pt.

† Eutec.

100 gms. ethyl acetate dissolve 13.05 gms. HgBr<sub>2</sub> at 18° (Naumana, 19)100 gms. methyl acetate dissolve 21.93 gms. HgBr<sub>2</sub> at 18° (*d*<sub>18</sub> sat. sol. = 1.05 (Naumana, 19)

## SOLUBILITY OF MERCURIC BROMIDE IN PYRIDINE. (Staronka, 1910.)

t°.	Mol. % HgBr <sub>2</sub> .	Gms. HgBr <sub>2</sub> per 100 Gms. C <sub>5</sub> H <sub>5</sub> N.	Solid Phase.	t°.	Mol. % HgBr <sub>2</sub> .	Gms. HgBr <sub>2</sub> per 100 Gms. C <sub>5</sub> H <sub>5</sub> N.	Solid Phase.
10	5	24	HgBr <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N	107*	39	291.5	HgBr <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N + HgBr <sub>2</sub> ·C <sub>5</sub> F
30	8	39.64	"	110	40.4	309	HgBr <sub>2</sub> ·C <sub>5</sub> H <sub>5</sub> N
50	11.2	57.49	"	120	45.5	381.3	"
80	17.5	96.68	"	123†	50	455.8	"
100	22	128.5	"	125	51	474.4	3HgBr <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N
110	24.5	147.8	"	130	54.2	539.4	"
118†	33.3	227.6	"	134†	60	683.7	"
110	35.5	250.8	"	133	64	810.4	"

\* Eutec.

† m. pt.

## SOLUBILITY OF MERCURIC BROMIDE IN QUINOLINE. (Staronka, 1910.)

t°.	Mol. % HgBr <sub>2</sub> .	Gms. HgBr <sub>2</sub> per 100 Gms. C <sub>8</sub> H <sub>7</sub> N.	Solid Phase.
88	4.4	12.85	HgBr <sub>2</sub> ·2C <sub>8</sub> H <sub>7</sub> N
111	8.9	27.28	"
127	14.3	46.58	"
134	17.6	61.16	"

Data for the solubility of mercuric bromide in nitrobenzene, in *p* nitrotoluer in *m* nitrotoluene, in *o* nitrotoluene and in  $\alpha$  nitronaphthalene, determined by t method of lowering of the freezing-point, are given by Mascarelli, 1906, and M<sub>2</sub> carelli and Ascoli, 1907. Data for HgBr<sub>2</sub> + Se are given by Olivari, 1912.

DISTRIBUTION OF MERCURIC BROMIDE BETWEEN WATER AND BENZENE  
(THIOPHENE FREE) AT 25°. (Sherrill, 1903.)

Mols. per Liter.		Dist. Coef.	Mols. per Liter.		Dist. Coef.
H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>6</sub> Layer.		H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>6</sub> Layer.	
0.017	0.194	0.876	0.00634	0.0715	0.89
0.01147	0.1303	0.88	0.00394	0.0436	0.90
0.00953	0.1074	0.89	0.00320	0.0353	0.90

Data are also given for the distribution between aqueous potassium iodide sol tions and thiophene free benzene at 25°.

Data for the solubility of mix crystals of HgBr<sub>2</sub> + HgI<sub>2</sub> in acetone at 25° ar in ethyl alcohol of *d*<sub>18</sub> = 0.8126 = 95% at 0°, 25° and 50° are given by Reinde (1900). In the case of acetone, the ratio of HgBr<sub>2</sub> in the solution increases wit increase of per cent of HgBr<sub>2</sub> in the solid phase. In the case of the alcohol sol tions the ratio in solution does not show such regular variations with change per cent of MgBr<sub>2</sub> in the solid phase.



**MERCURY CHLORIDE** (ic)  $\text{HgCl}_2$ , (ous)  $\text{Hg}_2\text{Cl}_2$ .

## SOLUBILITY OF MERCURIC CHLORIDE IN WATER.

Average curve from results of Etard, 1894; Foote, 1903; Osaka, 1903-08; Herz and Paul, 1913; Greenish and Smith, 1903; Schreinemakers and Thonus, 1912; Sherrill, 1903; Morse, 1902.

t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Sat. Sol.
0	3.5	25	6.9	80	23.1
10	4.6	30	7.7	100	38
15.5	5.3 ( $d_{15} = 1.047$ )	40	9.3	120	59
20	6.1	60	14	150	78.5

## SOLUBILITY OF MERCUROUS CHLORIDE IN WATER.

t°.	Gms. $\text{Hg}_2\text{Cl}_2$ per 100 Gms. Sat. Sol.	Authority.	t°.	Gms. $\text{Hg}_2\text{Cl}_2$ per 100 Gms. Sat. Sol.	Authority.
0.5	0.000140	(Conductivity, Kohlrausch, 1908.)	24.6	0.00028	(Kohlrausch, 1908.)
18	0.00075	(Indirect, Behrend, 1893.)	25	0.00047	(Sherrill, 1903.)
18	0.00021	(Conductivity, Kohlrausch, 1908.)	43	0.00070	(Kohlrausch, 1908.)
20	0.00038	(Ley and Heimbucher, 1904.)			

## SOLUBILITY OF MERCURIC CHLORIDE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE.

(Homeyer and Ritsert — Pharm. Ztg. 33, 738, '88.)

Per cent Concentration of NaCl Solutions.	Gms. $\text{HgCl}_2$ per 100 Gms. NaCl Solution at:		
	15°	65°	100°
0.5	10	13	44
1.0	14	18	48
5.0	30	36	64
10.0	58	68	110
25.0	120	142	196
26.0 (saturated)	128	152	208

## SOLUBILITY OF MERCURIC CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT:

0°.

(Ossel — Ann. chim. phys. [6] 17, 362, '89.)

20-25° (?).

(Ditte — *Ibid.* [5] 22, 551, '81.)

— Anal. chem. pays. [6] 17, 302, 89.)				(Litte — 1908. [5] 22, 551, 81.)		
G. Mole. HCl	per 100 cc. Sol. H <sub>2</sub> Cl.	Gms. per 100 cc. Sol. HCl. HgCl <sub>2</sub> .	Sp. Gr. of Solutions.	Parts HCl per 100 Parts H <sub>2</sub> O.	Parts HgCl <sub>2</sub> per 100 Parts Solution.	
4.3	9.7	1.57	13.11	1.117	0.0	6.8
9.9	19.8	3.61	18.04	1.238	5.6	46.8
17.8	35.5	6.49	32.44	1.427	10.1	73.7
26.9	55.6	9.81	49.04	1.665	13.8	87.8
32.35	68.9	11.76	58.80	1.811	21.1	127.4
34.25	72.4	12.48	62.40	1.874	31.0	141.9
41.5	85.5	15.13	75.65	2.023	50.0	148.0
48.1	88.6	17.54	87.70	2.066	68.0	154.0
70.9	95.7	25.84	129.20	2.198		

One liter of 0.1 N  $\text{Hg}(\text{NO}_3)_2$  solution dissolves 105 gms.  $\text{HgCl}_2$  at 25°.

(Morse, 1902.)

This result, together with distribution experiments, show that complexes of  $\text{HgCl}_2$  and  $\text{Hg}(\text{NO}_3)_2$  are formed.



SOLUBILITY OF MERCURIC CHLORIDE IN AQUEOUS SALT SOLUTION  
(Herz and Paul, 1913.)

In Aqueous Barium Chloride.		In Aqueous Calcium Chloride.		In Aqueous Lithium Chloride.		In Aqueous Mersuric Chloride.
Mols. per Liter.		Mols. per Liter.		Mols. per Liter.		Mol
BaCl <sub>2</sub> .	HgCl <sub>2</sub> .	CaCl <sub>2</sub> .	HgCl <sub>2</sub> .	LiCl.	HgCl <sub>2</sub> .	MgCl <sub>2</sub> .
0	0.265	0.190	0.364	0.414	0.351	0.16
0.385	0.697	0.402	0.766	0.835	0.666	0.41
0.572	1.167	0.656	1.108	1.271	1.021	0.57
0.776	1.620	0.964	1.811	1.738	1.678	0.99
1.336	2.645	1.429	2.645	2.265	2.214	1.32
3.030	5.348	1.723	3.304	3.091	2.896	1.72

In Aqueous Potassium Chloride.		In Aqueous Sodium Chloride.		In Aqueous Strontium Chloride.
Mols. per Liter.		Mols. per Liter.		Mols. per Liter.
KCl.	HgCl <sub>2</sub> .	NaCl.	HgCl <sub>2</sub> .	SrCl <sub>2</sub> .
0	0.265	0.201	0.372	0.164
0.1	0.381 (Sherrill, 1903.)	0.416	0.508	0.311
0.174	0.355	0.671	0.748	0.519
0.221	0.381	1.153	1.192	0.724
0.25	0.542 (Sherrill, 1903.)	1.941	2.022	1.046
0.683	0.836	3.162	3.434	1.384

SOLUBILITY OF MERCURIC CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE AT 20° AND VICE VERSA.

(Tichomirow, 1907; see also results by Foote and Levy on next page.)

Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.	Gms. per 100 Gms. H <sub>2</sub> O.		Solid
KCl.	HgCl <sub>2</sub> .		KCl.	HgCl <sub>2</sub> .	
0	7.39	HgCl <sub>2</sub>	20.35	29	HgCl <sub>2</sub> .KCl
1.12	11.63	"	26.31	34.83	"
2.39	15.72	"	30.32	39.10	"
4.05	22.17	"	34.12	42.82	" + H <sub>2</sub> O
4.84	25.16	" + 2HgCl <sub>2</sub> .KCl	34.18	39.34	HgCl <sub>2</sub> .
5.60	25.13	2 HgCl <sub>2</sub> .KCl	34.34	35.16	"
6.71	25.66	"	35.54	30.63	"
7.39	26.41	" + HgCl <sub>2</sub> .KCl	37.72	24.30	"
7.46	24.70	HgCl <sub>2</sub> .KCl	41.33	19.33	" + KCl
8.95	19.93	"	39.66	15.76	KCl
15	22.87	"	37.87	10.28	"
17.57	26.12	"	35.32	2.1	"

100 gms. 1 N aq. NaCl solution dissolve 25.08 gms. HgCl<sub>2</sub> at 25°.

(Or Data for the solubility of mercuric chloride in aqueous solutions of sucrose, tartaric and citric acids at 25° are given by Moles and Marc.)  
Data for equilibrium in the system, HgCl<sub>2</sub> + KOH + H<sub>2</sub>O at 25° are given by Herz, 1910.

Similar data for mercurous chloride + KOH + H<sub>2</sub>O at 25° are given by Herz, 1911.



**SOLUBILITY OF MIXTURES OF SODIUM AND MERCURIC CHLORIDE IN WATER AT 25°.**

(Foote and Levy—Am. Ch. J. 35, 239, '06.)

Gms. per 100 Gms. Solution.		Gms. per 100 Gms. Undissolved Residue.			Solid Phase.
NaCl.	HgCl <sub>2</sub> .	NaCl.	HgCl <sub>2</sub> .	H <sub>2</sub> O.	
26.5	none	100	none	none	NaCl
18.66	51.35	...	16.39	...	NaCl and NaCl.HgCl <sub>2</sub> .2H <sub>2</sub> O
18.71	51.32	...	21.98	...	
18.64	51.42	...	65.42	...	
18.87	51.26	...	71.25	...	
14.97	57.74	16.38	74.18	9.44	Double Salt NaCl.HgCl <sub>2</sub> .2H <sub>2</sub> O Calc. Comp. = 16.01% NaCl 74.14% HgCl <sub>2</sub> .85% H <sub>2</sub> O
14.03	59.69	16.36	74.21	9.43	
13.25	62.16	16.16	74.70	9.14	
13.17	62.59	15.96	74.76	9.28	
12.97	62.50	...	78.20	...	NaCl.HgCl <sub>2</sub> .2H <sub>2</sub> O and HgCl <sub>2</sub>
13.14	62.48	...	88.64	...	
13.15	62.55	...	90.83	...	
Two determinations made at 10.3° gave:					
19.46	46.49	67.46	29.19	3.35	
19.48	46.50	22.83	68.85	8.32	

**SOLUBILITY OF MIXTURES OF POTASSIUM AND MERCURIC CHLORIDES IN WATER AT 25°.**

(Foote and Levy.)

Composition of Solution. Grams per 100 Grams Solution.		Percentage Composition of Undissolved Residue			Solid Phase.
KCl.	HgCl <sub>2</sub> .	KCl.	HgCl <sub>2</sub> .	H <sub>2</sub> O.	
26.46	none	100	none	...	KCl
26.24	15.04	...	3.63	...	KCl and 2KCl.HgCl <sub>2</sub> .H <sub>2</sub> O
26.43	15.02	...	26.15	...	
26.33	15.02	...	52.01	...	
26.33	14.92	...	61.04	...	
23.74	18.91	34.61	61.66	3.73	2KCl.HgCl <sub>2</sub> .H <sub>2</sub> O Calc. Composition 34.05% KCl, 61.84% HgCl <sub>2</sub> , 4.11% H <sub>2</sub> O
22.36	21.39	34.77	62.02	3.21	
21.39	23.88	34.80	61.84	3.35	
20.32	27.62	...	65.24	...	
20.26	27.38	...	73.98	...	2KCl.HgCl <sub>2</sub> .H <sub>2</sub> O and KCl.HgCl <sub>2</sub> .H <sub>2</sub> O
7.85	25.34	21.89	75.10	3.01	
9.26	18.95	21.02	73.36	5.62	KCl.HgCl <sub>2</sub> .H <sub>2</sub> O Calc. Composition 20.52% KCl, 74.53% HgCl <sub>2</sub> , 4.95% H <sub>2</sub> O
7.80	19.56	20.76	73.06	6.18	
6.84	22.81	20.75	74.54	4.71	
6.66	24.32	20.54	73.99	5.47	
6.52	25.13	...	76.46	...	KCl.HgCl <sub>2</sub> .H <sub>2</sub> O and KCl.2HgCl <sub>2</sub> .2H <sub>2</sub> O
6.64	25.16	...	80.60	...	
6.27	25.11	12.09	83.20	4.71	KCl.2HgCl <sub>2</sub> .2H <sub>2</sub> O Calc. Composition 11.43% KCl, 83.05% HgCl <sub>2</sub> .5.52% H <sub>2</sub> O
5.77	24.73	11.87	83.18	4.95	
4.68	24.75	...	84.46	...	KCl.2HgCl <sub>2</sub> .2H <sub>2</sub> O and HgCl <sub>2</sub>
4.66	25.17	...	93.68	...	
4.69	24.82	...	98.50	...	
none	6.90	none	100.00	none	HgCl <sub>2</sub>



# MERCURIC CHLORIDE

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## SOLUBILITY OF MIXTURES OF MERCURIC AND RUBIDIUM (WATER AT 25°.

(Foote and Levy, 1906.)

Composition of Solution. Gms. per 100 Gms. Solution.		Percentage Composition of Undissolved Residue.			
RbCl.	HgCl <sub>2</sub>	RbCl.	HgCl <sub>2</sub> .	H <sub>2</sub> O.	
48.57	none	100	none	none	RbCl
46.76	9.18	88.04	11.24	0.72	RbCl an
47.54	9.49	60.33	37.51	2.16	
47.55	9.39	56.59	40.75	2.66	
47.3	9.47	46.73	49.38	3.88	2RbCl.F positiv HgCl <sub>2</sub>
47.65	10.35	46.50	50.92	2.58	
35.16	19.58	45.98	50.80	3.22	
34.77	19.94	43.07	52.44	4.49	2RbCl.F
34.76	20.10	41.10	55.36	3.54	2HgC
30.27	20.17	39.07	57.34	3.59	3RbCl.2
29.20	20.55	39.10	57.47	3.43	Calc. Co
27.38	20.63	38.67	57.40	3.93	38.55%
26.83	20.87	38.48	57.36	4.16	3.82%
27.09	20.97	31.40	64.35	4.25	3RbCl.2
26.15	20.58	30.34	65.48	4.18	RbCl.H <sub>2</sub>
23.81	18.71	30.87	65.10	4.03	Calc. Co
18.10	14.25	29.87	65.28	4.85	29.49%
10.87	10.42	29.33	66.15	4.52	4.40%
10.68	10.56	28.59	67.99	3.42	RbCl.H <sub>2</sub>
10.50	10.05	26.22	72.20	1.58	4HgCl
10.06	9.86	25.28	73.38	0.84	3RbCl.4 Calc. Co
8.48	8.71	25.30	73.15	1.55	
8.46	8.80	25.44	73.67	0.89	
5.68	8.70	25.09	73.46	1.45	24.76%
5.10	8.33	24.92	73.93	1.15	1.23%
3.43	8.25	22.79	75.72	1.49	3RbCl.4
3.38	8	12.68	86.74	0.58	5HgCl
2.98	7.71	8.40	91.24	...	RbCl.5H Calc. Co
1.89	7.64	8.38	91.78	...	
1.50	7.55	8.30	91.81	...	
1.10	7.21	8.07	91.58	...	8.20% R
0.79	7.16	6.91	93.15	...	RbCl.5H
0.84	7.42	2.27	97.09	...	
none	6.90	none	100	...	HgCl <sub>2</sub>

## SOLUBILITY OF MERCURIC CHLORIDE IN ACETIC (Etard, 1894.)

t°.	Gms. HgCl <sub>2</sub> per 100 Gms. Solution.	t°.	Gms. HgCl <sub>2</sub> per 100 Gms. Solution.	t°.
20	2.5	70	8.5	110
30	3.5	80	9.7	120
40	4.7	90	11	130
50	6	100	12.4	140
60	7.2			160



**SOLUBILITY OF MERCUROUS CHLORIDE (CALOMEL) IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE, BARIUM CHLORIDE, CALCIUM CHLORIDE AND OF HYDROCHLORIC ACID AT 25°.**

(Richards and Archibald, 1902.)

Solid phase in each case. Calomel + about 0.1 gm. of mercury.

In Aqueous NaCl.			In Aqueous BaCl <sub>2</sub> .		
Sp. Gr. of Solutions.	Gms. per Liter.		Sp. Gr. of Solutions.	Gms. per Liter.	
	NaCl.	HgCl.		BaCl <sub>2</sub> .	HgCl.
...	5.85	0.0041	1.088	104.15	0.044
1.040	58.50	0.041	1.134	156.22	0.088
1.078	119	0.129	1.174	208.30	0.107
1.093	148.25	0.194	1.263	312.54	0.231
1.142	222.3	0.380			
1.188	292.5	0.643			

In Aqueous CaCl <sub>2</sub> .			In Aqueous HCl.		
Sp. Gr. of Solutions.	Gms. per Liter.		Sp. Gr. of Solutions.	Gms. per Liter.	
	CaCl <sub>2</sub> .	HgCl.		HCl.	HgCl.
...	39.96	0.022	...	31.69	0.034
...	55.5	0.033	...	36.46	0.048
1.064	111	0.081	1.042	95.43	0.207
1.105	138.75	0.118	1.069	158.4	0.399
1.151	195.36	0.231	1.091	209.2	0.548
1.205	257.52	0.322	1.114	267.3	0.654
1.243	324.67	0.430	1.119	278.7	0.675
1.315	432.9	0.518	1.132	317.3	0.670
1.358	499.5	0.510	1.153	364.6	0.673

100 gms. bromoform, CHBr<sub>3</sub>, dissolve 0.055 gm. HgCl at 18°–20°. (Sulc., 1900.)

**SOLUBILITY OF MERCURIC CHLORIDE IN AQUEOUS ETHYL ALCOHOL AT 25°.**

(Abe, 1912.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
C <sub>2</sub> H <sub>5</sub> OH.	HgCl <sub>2</sub> .		C <sub>2</sub> H <sub>5</sub> OH.	HgCl <sub>2</sub> .	
0	6.80	HgCl <sub>2</sub>	45.84	15.36	HgCl <sub>2</sub>
5.08	6.65	"	49.86	18.18	"
14.49	6.41	"	53.61	21.40	"
21	6.55	"	57.26	24.51	"
26.25	7.31	"	60.55	27.67	"
31.53	8.51	"	63.95	29.86	"
36.85	10.32	"	67.39	32.40	"
41.36	12.64	"			

**SOLUBILITY OF MERCURIC CHLORIDE IN Aq. ETHYL ALCOHOL AT 25°.**

(Hers and Anders, 1907.)

Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	d <sub>25°</sub> of Solvent.	d <sub>25°</sub> of Sat. Sol.	Gms. HgCl <sub>2</sub> per 100 cc. Sat. Sol.
0	0.9971	1.0565	7.22
20.18	0.9665	1.0214	6.76
40.69	0.9302	1.0180	10.69
70.01	0.8632	1.0616	23.60
100	0.7856	1.1067	36.86



# MERCURY CHLORIDE

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## SOLUBILITY OF MERCURIC CHLORIDE IN AQUEOUS METHYL ALCOHOL (Herz and Anders, 1907.)

Wt. % CH <sub>3</sub> OH in Solvent.	$d_{25}^{\circ}$ of Solvent.	$d_{25}^{\circ}$ of Sat. Sol.	Gms. HgCl <sub>2</sub> per 100 cc. Sat. Sol.
10.60	0.9792	1.0441	7.90
30.77	0.9481	1.0420	11.31
37.21	0.9369	1.0507	13.43
47.06	0.9186	1.0809	19.71
64	0.8800	1.2015	38.44
78.05	0.8489	1.3314	57.17
100	0.7879	1.2160	48.62

100 cc. 90% ethyl alcohol dissolve 27.5 gms. HgCl<sub>2</sub> at 15.5°,  $d_{15}^{\circ}$  sat. sol.

100 gms. 99.2% ethyl alcohol dissolve 33.4 gms. HgCl<sub>2</sub> at 25°. (Greenish and S

" - abs. " " 49.5 " " (Oss)

" - " methyl " " 52.9 " " (de B

" " " " " 1.2 " " at 19.5° and 66.9 gr (de B

" " " " " " at the crit. temp. (Centners

## SOLUBILITY OF MERCURIC CHLORIDE IN METHYL, ETHYL P n BUTYL, ISO BUTYL AND ALLYL ALCOHOLS.

(Etard — Ann. chim. phys. [7] 2, 563, '94.)

NOTE. — For the solubility in Me, Et, and propyl alcohols temperature, see Rohland — Z. anorg. Ch. 18, 328, '98; at 8.5°, 38.2°, see Timofejew — Compt. rend. 112, 1224, '91; in Me alcohols at 25°, see de Bruyn — Z. physik. Ch. 10, 783, '92. The minations of these investigators agree well with those of Etard are given below.

t°.	Grams HgCl <sub>2</sub> per 100 Grams Saturated Solution in:				
	CH <sub>3</sub> OH.	C <sub>2</sub> H <sub>5</sub> OH.	C <sub>3</sub> H <sub>7</sub> OH.	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>3</sub> OH.	(CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> OH. CH <sub>2</sub> =CHCH <sub>2</sub> OH.
-30	...	14.5	15.0	...	...
-20	...	20.1	15.7	13.5	...
-10	15.2	26.5	16.5	13.7	...
0	20.1	29.8	17.4	14.0	5.2
+10	26.3	30.6	18.0	14.3	6.0
20	34.0	32.0	18.8	14.6	6.8
25	40.0	32.5	19.5	15.5	7.2
30	44.4	33.7	20.0	16.5	7.5
40	58.6	35.6	23.0	19.6	9.7
60	62.5	41.2	29.8	26.5	17.0
80	66.0	47.5	36.8	33.0	24.9
100	70.1	54.3	43.8	...	31.7
120	73.5	61.5	50.6	...	39.2
150	78.5	...	...	...	...

## SOLUBILITY OF MERCURIC CHLORIDE IN AQ. ETHYL ACETATE AT (Herz and Anders, 1907.)

Wt. % CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub> in Solvent.	$d_{25}^{\circ}$ of Solvent.	$d_{25}^{\circ}$ of Sat. Sol.	Gms. HgCl <sub>2</sub> 100 cc. Sat. S
0	0.9971	1.0565	7.22
4.39*	...	1.0581	7.38
96.76†	...	1.2371	41.55
100‡	0.884	1.1126	26.42

\* Almost sat. with ethyl acetate. † Ethyl acetate almost sat. with H<sub>2</sub>O. ‡ (b. pt. =



**SOLUBILITY OF MERCURIC CHLORIDE IN WATER-ETHER MIXTURES AT 25°.**  
 (Abe, 1912.)

Gms. per 100 Gms. Sat. Sol.			Solid Phase.
HgCl <sub>2</sub> .	Ether.	H <sub>2</sub> O.	
6.92	87.86	5.22*	HgCl <sub>2</sub>
5.2	1.2	93.6	"
4.3	5.2	90.5	"
2.8	5.4	91.8	"
1.5	5.4	93.1	"

\* (Solvent, ether sat. with H<sub>2</sub>O.)
**SOLUBILITY OF MERCURIC CHLORIDE IN MIXTURES OF ETHER AND ETHYL ALCOHOL AT 25°.**  
 (Abe, 1912.)

Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.	
HgCl <sub>2</sub> .	C <sub>2</sub> H <sub>5</sub> OH.	HgCl <sub>2</sub> .	C <sub>2</sub> H <sub>5</sub> OH.
32.43	67.57	36.29	27.16
35.50	58.59	34.08	22.48
37.39	51.02	28.55	15.20
37.96	44.79	20.67	8.97
38.24	38.69	5.49	0
37.75	32.84		

**SOLUBILITY OF MERCURIC CHLORIDE IN MIXTURES OF ALCOHOLS AT 25°.**  
 (Herz and Kuhn, 1908.)

In Mixtures of Ethyl and Methyl Alcohols.				In Mixtures of Ethyl and Propyl Alcohols.				In Mixtures of Methyl and Propyl Alcohols.			
% C <sub>2</sub> H <sub>5</sub> OH in Solvent.	d <sub>20</sub> of Sat. Sol.	Gms. HgCl <sub>2</sub> per 100 cc. Sat. Sol.	% C <sub>2</sub> H <sub>5</sub> OH in Solvent.	d <sub>20</sub> of Sat. Sol.	Gms. HgCl <sub>2</sub> per 100 cc. Sat. Sol.	% C <sub>2</sub> H <sub>5</sub> OH in Solvent.	d <sub>20</sub> of Sat. Sol.	Gms. HgCl <sub>2</sub> per 100 cc. Sat. Sol.	% C <sub>2</sub> H <sub>5</sub> OH in Solvent.	d <sub>20</sub> of Sat. Sol.	Gms. HgCl <sub>2</sub> per 100 cc. Sat. Sol.
0	1.107	36.86	0	1.1070	36.86	0	1.2160	48.62	0	1.2160	48.62
4.37	1.130	39.43	8.1	1.0988	36.67	11.11	1.2278	50.34	11.11	1.2278	50.34
10.40	1.157	42.61	17.85	1.0857	34.06	23.80	1.2848	57.14	23.80	1.2848	57.14
1.02	1.294	58.37	56.6	1.0272	27.11	65.20	1.1568	42.28	65.20	1.1568	42.28
1.69	1.321	61.67	88.6	0.9854	21.66	91.80	1.0090	25.09	91.80	1.0090	25.09
1.77	1.288	57.82	91.2	0.9824	21.60	93.75	1.0029	23.23	93.75	1.0029	23.23
1.25	1.254	53.85	95.2	0.9772	20.87	96.6	0.9851	21.52	96.6	0.9851	21.52
	1.216	48.62	100	0.9720	20.03	100	0.9720	20.03	100	0.9720	20.03

**SOLUBILITY OF MERCURIC CHLORIDE IN MIXTURES OF ETHYL ALCOHOL AND BENZENE AND OF ETHYL ALCOHOL AND CHLOROFORM AT DIFFERENT TEMPERATURES.**  
 (Dukelski, 1907.)

In a Mixture of one mol. C <sub>2</sub> H <sub>5</sub> OH and one mol. C <sub>6</sub> H <sub>6</sub> .		In a Mixture of two mols. C <sub>2</sub> H <sub>5</sub> OH and one mol. C <sub>6</sub> H <sub>6</sub> .		In a Mixture of one mol. C <sub>2</sub> H <sub>5</sub> OH and one mol. CHCl <sub>3</sub> .		In a Mixture of two mols. C <sub>2</sub> H <sub>5</sub> OH and one mol. CHCl <sub>3</sub> .	
Gms. HgCl <sub>2</sub> per 100 Gms. Sat. Sol.	t°.	Gms. HgCl <sub>2</sub> per 100 Gms. Sat. Sol.	t°.	Gms. HgCl <sub>2</sub> per 100 Gms. Sat. Sol.	t°.	Gms. HgCl <sub>2</sub> per 100 Gms. Sat. Sol.	t°.
15.20	-5.2	19.45	-20.5	3.82	-20.5	6.60	
15.40	0	20.13	-12	4.43	0	7.69	
16.38	9.1	21.65	0	4.89	8	8.96	
18.40	20.9	23.57	8	5.37	23	10.66	
18.50	24.4	24.19	23	7.12	38.5	12.50	
19.33	36.5	26.53	38.5	8.51	44.2	14.40	
21.34	53.7	31.27	44.2	9.51			
24.84	74	38.74	45.6	9.98			
24.42							

Some of the determinations were made by the direct method of saturating the solution at a given temperature and determining the dissolved material by evaporating and weighing. Others were made by the synthetic method of Alexejew.



SOLUBILITY OF MERCURIC CHLORIDE IN MIXTURES OF METHYL  
CHLOROFORM, METHYL ALCOHOL AND CARBON TETRACHLORIDE,  
ALCOHOL AND DICHLORETHANE AT DIFFERENT TEMPERATURES  
(Dukelski, 1907.)

In a Mixture of one mol. $\text{CH}_3\text{OH}$ + one mol. $\text{CHCl}_3$ .		In a Mixture of two mols. $\text{CH}_3\text{OH}$ + one mol. $\text{CHCl}_3$ .		In a Mixture of two mols. $\text{CH}_3\text{OH}$ + one mol. $\text{CCl}_4$ .		In a two r + one	
t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Sat. Sol.	t°.	
-12	1.73	-12	3.33	0	5.20	0	
0	3.51	0	6.73	7.7	6.69	12	
8	5.63	8	8.21	24.9	14.06	20	
23	10.15	23	16.56	30.6	19.40	25	
24.9	10.71	24.9	18.45	35.5	20.50	30	
30.6	11.40	30.6	19.70	36.1	21.80	37	
38.5	12.02	38.5	20.83	48.5	21.90	45	

SOLUBILITY OF MERCURIC CHLORIDE IN MIXTURES OF METHY  
AND BENZENE AT DIFFERENT TEMPERATURES.  
(Timofeiew, 1894.)

In a Mixture of one mol. $\text{CH}_3\text{OH}$ + one mol. $\text{C}_6\text{H}_6$ .		In a Mixture of $\text{CH}_3\text{OH}$ + two mols	
t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{HgCl}_2$ Gms. Sat
0	8	0	4.
21-25	23.9	21-25	17.
30	27.3	30	18
37	28.1	37	18..

SOLUBILITY OF MERCURIC CHLORIDE IN BENZENE, IN DICHL  
AND IN ETHYLACETATE AT DIFFERENT TEMPERATURE  
(Dukelski, 1907.)

In $\text{C}_6\text{H}_6$ .		In $\text{C}_2\text{H}_5\text{Cl}$ .		In $\text{CH}$	
t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Sat. Sol.	t°.	
6.5	0.26	0	1.33	0	
18	0.53	12.5	1.55	6.5	
34.1	0.64	25.3	1.73	26.1	
54.1	1.02	33	2.05	38.5	
69	1.39	45.9	2.42	45.3	

SOLUBILITY OF MERCURIC CHLORIDE IN MIXTURES OF BENZENE  
ACETATE, CHLOROFORM AND ETHYL ACETATE AND OF CARBON TE  
AND ETHYL ACETATE.

(Dukelski, 1907.)

In a Mixture of one mol. $\text{C}_6\text{H}_6$ + one mol. $\text{CH}_3\text{COOC}_2\text{H}_5$ .		In a Mixture of one mol. $\text{CHCl}_3$ + one mol. $\text{CH}_3\text{COOC}_2\text{H}_5$ .		In a Mixt $\text{CCl}_4$ + $\text{CH}_3$	
t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Sat. Sol.	t°.	
0	9.62	0	3.34	0	
6.5	9.62	26.1	4.07	10.3	
25.7	9.78	36.1	4.78	25.7	
27.6	9.98	46	5.38	27.6	
35.5	10.81	48.5	5.10	38.5	
45.3	13.69			45.3	



### SOLUBILITY OF MERCURIC CHLORIDE IN ETHYL ACETATE AND IN ACETONE.

(Reed, 1894; von Lasczynski, 1894; Krug and McElroy, 1892; Linebarger, 1894; Aten, 1905-06.)

NOTE.—The results obtained by the above-named investigators were calculated to a common basis and plotted on cross-section paper. The variations which were noted could not be satisfactorily harmonized, consequently all the results are included in the following table:

#### SOLUBILITY.

In Ethyl Acetate.					In Acetone.			
Gms. HgCl <sub>2</sub> per 100 Grams Solution.					Gms. HgCl <sub>2</sub> per 100 Gms. Solution.			
t°.	Lasczynski.	Aten.	Linebarger.	Etard.	K and McE.	Lasczynski.	Aten.	Etard.
-10	...	23.0	...	40	...	...	44.0 *	57.0
0	22.0	23.2	32.0	40	...	49.7	43.0 *	61.7
+10	22.2	23.5	32.5	40	...	52.0	51.0 * - 58.9 †	61.7
20	22.5	23.4	32.7	40	...	54	58.5 †	61.7
25	22.7	23.5	33.0	40	37.4	55.2	58.2 †	61.7
30	23.0	...	33.2	40	...	...	...	61.7
40	23.5	...	33.5	40	...	...	...	61.7
50	24.0	...	33.5	41	...	...	...	61.7
60	24.7	...	...	42.5	...	...	...	61.7
80	26.0	...	...	45.2	...	...	...	61.7
100	.. -	...	...	48.0	...	...	...	...
120	.. -	...	...	50.8	...	...	...	...
150	.. -	...	...	55.0	...	...	...	...

(\*) Solid phase HgCl<sub>2</sub>(CH<sub>3</sub>)<sub>2</sub>CO.

(†) Solid Phase HgCl<sub>2</sub>.

100 gms. absolute acetone dissolve 143 gms. HgCl<sub>2</sub> at 18°. (Naumann, 1904.)

100 gms. ethyl acetate ( $d_{44} = 0.8995$ ) dissolve 48.8 gms. HgCl<sub>2</sub> at 18°. (Naumann, 1910.)

100 gms. methyl acetate ( $d_{44} = 0.935$ ) dissolve 42.6 gms. HgCl<sub>2</sub> at 18°. (Naumann, 1909.)

### SOLUBILITY OF MERCURIC CHLORIDE IN SEVERAL SOLVENTS.

(Arctowski, 1894; von Lasczynski, 1894; Sulc, 1900.)

In Carbon Bisulphide (A.).		In Benzene (von L.).		In Several Solvents at 18-20° (S.).	
t°.	Gms. HgCl <sub>2</sub> per 100 Gms. Solution.	t°.	Gms. HgCl <sub>2</sub> per 100 Gms. Solution.	Solvent.	Gms. HgCl <sub>2</sub> per 100 Gms. Solvent.
-10	0.010	15	0.537	CHBr <sub>3</sub>	0.486
0	0.018	41	0.616	CHCl <sub>3</sub>	0.106
10	0.026	55	0.843	CCl <sub>4</sub>	0.002
15	0.032	84	1.769	C <sub>2</sub> H <sub>5</sub> Br	2.010
20	0.042			C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	1.530
25	0.053				
30	0.063				



SOLUBILITY OF MERCURIC CHLORIDE IN MIXTURES OF ACETONE AND BENZENE  
ETHER AND CHLOROFORM AND OF ETHYL ACETATE AND BENZENE AT 25°  
(Marden and Dover, 1917.)

In Mixtures of $\text{CH}_3\text{COCH}_3 + \text{C}_6\text{H}_6$ .		In Mixtures of $(\text{C}_2\text{H}_5)_2\text{O} + \text{CHCl}_3$ .		In Mixtures of $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{C}_6\text{H}_6$ .	
Gms. $\text{CH}_3\text{COCH}_3$ per 100 Gms. Mixture.	Gms. $\text{HgCl}_2$ per 100 Gms. Mixed Solvent.	Gms. $\text{CHCl}_3$ per 100 Gms. Mixture.	Gms. $\text{HgCl}_2$ per 100 Gms. Mixed Solvent.	Gms. $\text{CH}_3\text{COOC}_2\text{H}_5$ per 100 Gms. Mixture.	Gms. $\text{HgCl}_2$ per 100 Gms. Mixed Solvent.
100	140	0	6.95	100	49.3
90	117	10	5.85	90	26
80	96.5	20	4.73	80	22.1
70	77	30	3.70	70	18.1
60	60	40	2.80	60	14.2
50	45	50	2.10	50	11
40	31.4	60	1.48	40	8
30	20	70	0.95	30	5.4
20	10.7	80	0.657	20	3.1
10	3.9	90	0.328	10	1.6
0	0.66	100	0.128	0	0.66

SOLUBILITY OF MERCURIC CHLORIDE IN BENZENE.

(Average curve from results of Linebarger, 1895; Sherrill, 1903; and Marden and Dover, 1917.)

t°.	Gms. $\text{HgCl}_2$ per 100 Gms. $\text{C}_6\text{H}_6$ .	t°.	Gms. $\text{HgCl}_2$ per 100 Gms. $\text{C}_6\text{H}_6$ .
0	0.20	25	0.64
10	0.39	30	0.71
20	0.56	40	0.84

SOLUBILITY OF MERCURIC CHLORIDE IN ABSOLUTE ETHYL ETHER —  
(Etard, 1894; Laszcynski, 1894; Köhler, 1879.)

t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Solution.	t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Solution.	t°.	Gms. $\text{HgCl}_2$ per 100 Gms. Solution.
-20	6	60	6	90	7.
0	6	70	6.4	100	8
20	6	80	7	110	8.5

SOLUBILITY OF MERCURIC CHLORIDE IN CHLORINATED HYDROCARBONS AT 25°  
(Hoffmann, Kirmreuther and Thal, 1910.)

Solvent.	Formula.	Gms. $\text{HgCl}_2$ per 100 Gms. Solvent.	Solvent.	Formula.	Gms. $\text{HgCl}_2$ per 100 Gms. Solvent.
Ethylene Chloride	$\text{CH}_2\text{Cl}.\text{CH}_2\text{Cl}$	1.229	Dichlorethylene	$\text{CHCl}.\text{CHCl}$	0.1
Tetrachlorethane	$\text{C}_2\text{H}_2\text{Cl}_4$	0.090	Trichlorethylene	$\text{CHCl}.\text{CCl}_2$	0.0
Chloroform	$\text{CHCl}_3$	0.101	Tetrachlorethylene	$\text{CCl}_2.\text{CCl}_2$	0.0
Pentachlorethane	$\text{C}_2\text{HCl}_5$	0.0193	Carbontetrachloride	$\text{CCl}_4$	tr

100 gms. 95% formic acid dissolve 2.1 gm.  $\text{HgCl}_2$  at 19°. (Aschan,

100 gms. 95% formic acid dissolve 0.02 gm.  $\text{Hg}_2\text{Cl}_2$  at 16.5°. "

100 cc. anhydrous hydrazine dissolve 1 gm.  $\text{HgCl}_2$  with decomp. at room t (Welsh and Broderson,

100 cc. anhydrous hydrazine dissolve 1 gm.  $\text{Hg}_2\text{Cl}_2$  with decomp. at room t (Welsh and Broderson,

100 gms. glycerol dissolve 80 gms.  $\text{HgCl}_2$  at 25°. (Moles and Marquina,

100 gms. glycerol dissolve 8 gms.  $\text{HgCl}_2$  ?  $\text{Hg}_2\text{Cl}_2$  at 15-16°. (Ossendowski,

100 gms. anhydrous lanolin (m. pt. about 46°) dissolve 1.55 gms.  $\text{HgCl}_2$  at 25°. (Klose,



## SOLUBILITY OF MERCURIC CHLORIDE IN PYRIDINE.

(McBride, 1910.)

terminations at the lower temperatures were made by stirring an excess with pyridine and analyzing the sat. solution. Those at the higher temperatures were made by the synthetic method.

Gms. HgCl <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. HgCl <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.
2.76	HgCl <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N	94.7	60.72	HgCl <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N+3HgCl <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N
7.86	"	74.7	48.38	HgCl <sub>2</sub> ·C <sub>5</sub> H <sub>5</sub> N(unstable)
13.14	"	83.5	50.53	" (stable)
17.34	"	90.4	53.41	"
19.78	"	97	56.45	"
22.65	"	100.5	57.84	"
24.46	"	104.2	60.72	"
29.29	"	107	63.06	" (unstable)
34.94	"	106.2	...	" +3HgCl <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N
40.36	"	95.2	60.77	3HgCl <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N (unstable)
46.44	"	106.4	61.93	" (stable)
...	" +HgCl <sub>2</sub> ·C <sub>5</sub> H <sub>5</sub> N	109.8	62.58	"
51.52	HgCl <sub>2</sub> ·2C <sub>5</sub> H <sub>5</sub> N (unstable)	114	63.18	"
56.45	"	124.2	65	"
60.09	"	145.5	69.66	"

π this system are also given by Staronka (1910).

κ the solubility of HgCl<sub>2</sub>·2C<sub>5</sub>H<sub>5</sub>N and of Hg(NO<sub>3</sub>)<sub>2</sub>·2C<sub>5</sub>H<sub>5</sub>N·2H<sub>2</sub>O in solution of pyridine at 18°.1 are given by Strömholm (1908).

τ the solubility of diamine mercuric chloride, (NH<sub>4</sub>)<sub>2</sub>HgCl<sub>2</sub> - NH<sub>2</sub>HgCl, solutions of ammonia at 17.5° are given by Strömholm (1908).

SOLUBILITY OF MERCURIC CHLORIDE AND OF DOUBLE MERCURIC AND METHYL AMINE CHLORIDE (CH<sub>3</sub>)<sub>4</sub>NC1.6HgCl<sub>2</sub> IN AQ. ETHER

° (Strömholm — J. pr. Ch. [2] 66, 443, '02; Z. physik. Chem. 44, 64, '03.)

Molecular Concentration per Liter.			Grams per Liter of Solution.		
gO.	HgCl <sub>2</sub> (*).	HgCl <sub>2</sub> (†).	H <sub>2</sub> O.	HgCl <sub>2</sub> (*).	HgCl <sub>2</sub> (†).
0	0.1515	0.0342	0	41.16	9.26
0.56	0.1795	0.0428	1.18	48.64	11.60
1.311	0.2069	0.0516	2.36	56.08	14.00
1.956	0.2339	0.0603	3.52	63.38	16.34
2.611	0.2489	0.0690	4.70	70.16	18.70
3.267	0.2849	0.0779	5.88	77.20	21.10
3.922	0.3100	0.0866	7.06	84.02	23.48

is in this column are for solutions in contact with the Solid Phase HgCl<sub>2</sub>. (†) Results in are for solutions in contact with the Solid Phase (CH<sub>3</sub>)<sub>4</sub>NC1.6HgCl<sub>2</sub>.

## SOLUBILITY OF MERCURIC CHLORIDE AND OF DOUBLE MERCURIC AND METHYL AMINE CHLORIDE IN ALCOHOL-ETHER SOLUTIONS

° (Strömholm.)

Grams C <sub>2</sub> H <sub>5</sub> OH per Liter.	Grams HgCl <sub>2</sub> (*) per Liter.	Grams HgCl <sub>2</sub> (†) per Liter.
0.0	41.16	9.26
4.58	50.00	11.87
9.16	58.76	14.38
13.74	66.96	16.90



SOLUBILITY OF DOUBLE MERCURIC CHLORIDES IN AQUEOUS AETHER AT 16.6°.

(Strömholm, 1902, 1903.)

Mol. Conc. of $\text{HgCl}_2$ per Liter of:				Gms. $\text{HgCl}_2$ per Liter of:				Solid
Pure Ether.	Aq. Ether (1).	Aq. Ether (2).	Aq. Ether (3).	Pure Ether.	Aq. Ether (4).	Aq. Ether (5).	Aq. Ether (6).	
0.1515	0.2387	0.2647	0.3196	41.04	64.69	71.71	86.58	$\text{HgCl}_2$
0.0673	0.1157	0.1293	0.1617	18.23	31.41	35.05	43.79	$(\text{CH}_3\text{CH}_2\text{C}_2\text{H}_5)_2\text{HgCl}_2$
0.0404	0.0720	0.0835	0.1034	10.95	19.51	22.61	28.01	$(\text{CH}_3\text{C}_2\text{H}_5\text{CH}_2)_2\text{HgCl}_2$
0.0342	...	0.0706	...	9.26	...	19.10	...	$(\text{CH}_3)_2\text{NC}$
0.0264	...	0.0568	...	7.14	...	15.39	...	$(\text{C}_2\text{H}_5)_2\text{SC}$
0.0209	0.0400	0.0460	0.0594	5.66	10.83	12.48	16.10	$(\text{CH}_3\text{C}_2\text{H}_5)_2$
0.0063	...	0.0144	...	1.70	...	3.90	...	$(\text{CH}_3)_2\text{H}_2\text{N}$

(1) containing 0.21055 mol.  $\text{H}_2\text{O}$  per liter. (2) 0.2756 mol.  $\text{H}_2\text{O}$  per liter. (3) 0.421 m  
(4) containing 3.79 gms.  $\text{H}_2\text{O}$  per liter. (5) 4.97 gms.  $\text{H}_2\text{O}$  per liter. (6) 7.59 gms.  $\text{H}_2\text{O}$

SOLUBILITY OF MIXTURES OF MERCURIC AND POTASSIUM CHLORIDE

Absolute Alcohol. (Foote, 1910.)

Acetone. (Foote, 1910.)

Gms. per 100 Gms. Sat. Solution.		Solid Phase.	Gms. per 100 Gms. Sat. Solution.		Solid
KCl.	$\text{HgCl}_2$ .		KCl.	$\text{HgCl}_2$ .	
0.21	33.69	$\text{HgCl}_2 + 5\text{KCl} \cdot 6\text{HgCl}_2 \cdot 2\text{C}_2\text{H}_5\text{OH}$	1.27	61.87	$\text{HgCl}_2 + \text{KCl}_5$
0.28	33.80	"	1.39	60.68	$\text{KCl}_5\text{HgCl}_2$
0.22	24.84	$5\text{KCl} \cdot 6\text{HgCl}_2 \cdot 2\text{C}_2\text{H}_5\text{OH}$	2.58	55.85	"
0.28	6.21	"	2.78	54.41	"
0.25	1.65	$5\text{KCl} \cdot 6\text{HgCl}_2 \cdot 2\text{C}_2\text{H}_5\text{OH} + \text{KCl}$	2.93	48.13	5.6.2
0.17	1.57	"	2.52	18.04	"
0.38	1.03	"	3.34	13.26	"
			2.92	11	"

5.6.2 =  $5\text{KCl} \cdot 6\text{HgCl}_2$

100 gms. of sat. abs. alcohol solution of  $\text{HgCl}_2 + \text{NaCl}$  contain  $\text{HgCl}_2$  and 3.01 gms.  $\text{NaCl}$  at 25°.

SOLUBILITY OF MERCURIC CHLORIDE AND SODIUM CHLORIDE ACETATE AT 40°.

(Linebarger — Am. Ch. J. 16, 214, '94.)

Mols. per 100 Mols. Acetate.		Gms. per 100 Gms. Acetate.		Gms. per 100 Gms. Solution.	
NaCl.	$\text{HgCl}_2$ .	NaCl.	$\text{HgCl}_2$ .	NaCl.	$\text{HgCl}_2$ .
0.8	12.9	0.53	39.7	0.53	28.4
2.3	12.4	1.53	38.15	1.51	27.61
4.3	16.4	2.85	50.44	2.78	33.54
9.1	22.85	6.05	86.14	5.60	46.28
18.5	34.9	12.29	107.4	10.95	51.76
20.0	40.0	13.29	123.0	11.73	55.18

The double salt  $(\text{HgCl}_2)_2 \cdot \text{NaCl}$  is formed under proper co

DISTRIBUTION OF MERCURIC CHLORIDE BETWEEN WATER AND (Linhart, 1915.)

Results at 25°.

Results at 40°

Mols. $\text{HgCl}_2$ per Liter:		Conc. in $\text{H}_2\text{O}$ Conc. in $\text{C}_2\text{H}_5$	Mols. $\text{HgCl}_2$ per Liter:	
$\text{C}_2\text{H}_5$ Layer.	$\text{H}_2\text{O}$ Layer.		$\text{C}_2\text{H}_5$ Layer.	$\text{H}_2\text{O}$ Layer.
0.02100	0.2866	13.65	0.02047	0.34600
0.01224	0.15777	12.91	0.015296	0.18470
0.005244	0.064756	12.35	0.011774	0.138228
0.000618	0.007382	11.95	0.008041	0.091959
0.000310	0.003696	11.90	0.004140	0.04586
0.000155	0.001845	11.90	0.000847	0.009153



# DISTRIBUTION OF MERCURIC CHLORIDE BETWEEN WATER AND ETHER.

(Hantzsch and Sebalt, 1899.)

c. ether + 50 cc. sat. aqueous  $\text{HgCl}_2$  solution were shaken together at various temperatures and after equilibrium was established the  $\text{HgCl}_2$  in each determined.

°C.	Mols. $\text{HgCl}_2$ per Liter:		$\frac{c_1}{c_2}$
	$\text{H}_2\text{O}$ Layer ( $c_1$ ).	$(\text{C}_2\text{H}_5)_2\text{O}$ Layer ( $c_2$ ).	
0	0.0056	0.01407	0.391
10	0.0066	0.01415	0.467
17.5	0.0090	0.02150	0.419
25	0.0095	0.02076	0.429

determinations by Skinner (1892) at room temp. using concentrations of  $\frac{1}{2}$  in the aqueous layer varying from 1.4 to 5.9 per cent, gave a distribution coefficient,  $\frac{c_1}{c_2}$  = approximately 0.23.

# DISTRIBUTION OF MERCURIC CHLORIDE BETWEEN AQUEOUS HCl AND ETHER

AT 18°. (Mylius, 1911.)

When 1 gm. of Hg as  $\text{HgCl}_2$  is dissolved in 100 cc. of  $\text{H}_2\text{O}$  or aqueous HCl and then with 100 cc. of ether, the percentage of the Hg which goes into the ether layer is as follows:

Conc. of Aq. HCl	0 ( $=\text{H}_2\text{O}$ )	1	10	20
per cent Hg in Ether Layer	69.4	13	0.4	0.2

# DISTRIBUTION OF MERCURIC CHLORIDE BETWEEN WATER AND TOLUENE AT 24°.

(Brown, 1898.)

Gms. $\text{HgCl}_2$ per 100 cc.		Gms. $\text{HgCl}_2$ per 100 cc.	
$\text{H}_2\text{O}$ Layer.	$\text{C}_6\text{H}_5\text{CH}_3$ Layer.	$\text{H}_2\text{O}$ Layer.	$\text{C}_6\text{H}_5\text{CH}_3$ Layer.
0.442	0.0270	1.816	0.130
0.732	0.0488	3.766	0.292
0.780	0.0542	3.754	0.298
1.192	0.0812	6.688*	0.528*

\* This solution saturated.

Results at Dif. Temperatures.

(Hantzsch and Vagt, 1901.)

Results at 25°.

(Morse, 1902; Drucker, 1912; Hantzsch and Vagt, 1901.)

Mols. $\text{HgCl}_2$ per Liter:			$\frac{c_1}{c_2}$	Mols. $\text{HgCl}_2$ per Liter:			$\frac{c_1}{c_2}$
$\text{H}_2\text{O}$ Layer ( $c_1$ ).	$\text{C}_6\text{H}_5\text{CH}_3$ Layer ( $c_2$ ).	$\frac{c_1}{c_2}$		$\text{H}_2\text{O}$ Layer ( $c_1$ ).	$\text{C}_6\text{H}_5\text{CH}_3$ Layer ( $c_2$ ).	$\frac{c_1}{c_2}$	
0.0578	0.0047	12.35		0.18410	0.01590	11.6	
0.0575	0.0050	11.60		0.09193	0.00807	11.4	
0.0576	0.0050	11.40		0.04593	0.00410	11.1	
0.0574	0.0051	11.20		0.02289	0.00211	10.8	
0.0573	0.0052	11.25		0.01142	0.00108	10.5	
				0.00573	0.00057	10	

Data for the effect of  $\text{Hg}(\text{NO}_3)_2$  upon the distribution are given by Morse (1902). Results for the effect of  $\text{ZnCl}_2$  are given by Drucker (1912).

# FREEZING-POINT DATA (Solubilities, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES:

Mercuric Chloride	+ Mercuric Iodide	(Pados and Tibaldi, 1903.)
"	+ Selenium	(Olivari, 1909.)
"	+ Sulfur	"
"	+ Nitrobenzene	(Mascarelli, 1906.)
"	+ <i>o</i> and <i>p</i> Nitrotoluene	(Mascarelli, 1906, 1907, 1909.)
"	+ Urethan	( " 1908, 1909.)
"	+ " + $\alpha$ Nitronaphthalene	( " 1906, 1907.)
"	+ " + <i>p</i> Nitrotoluene	( " 1908.)
"	+ $\alpha$ Nitronaphthalene	( " 1906, 1907.)
"	+ <i>p</i> Nitranisole	( " 1906.)



**MERCURY CINNAMATE** (ic)  $(C_6H_5CH.CHCOO)_2Hg \cdot 7H_2O$ .100 gms.  $H_2O$  dissolve about 0.03 gm. mercuric cinnamate at  $25^\circ$ . (De Jong, 1904)100 gms.  $H_2O$  dissolve about 0.53 gm. Hg cinnamate at  $100^\circ$ . (Tarugi & Checchi, 1904)**MERCURIC CYANIDE**  $Hg(CN)_2$ .

## SOLUBILITY IN WATER.

t°.	Gms. $Hg(CN)_2$ per 100:		Authority.
	Gms. $H_2O$ .	cc. Sat. Sol.	
— 0.45 Eutec. about 11		...	(Guthrie, 1878.)
13.5	9.3	...	(Timofeiew, 1894.)
15	12.5	...	(Marsh and Struthen, 1902.)
20	...	9.3	(Konowalow, 1898, 1899.)
25	...	11.12	(Sherrill, 1903.)
25	11.27	10.95 ( $d_{25} = 1.0813$ )	(Herz and Anders, 1907.)
101.1	53.85	...	(Griffiths.)

One liter 5.2% aqueous  $NH_3$  solution dissolves 204.3 gms.  $Hg(CN)_2$  at about  $20^\circ$ . (Konowalow, 1898.)SOLUBILITY OF MERCURIC CYANIDE IN AQUEOUS POTASSIUM CYANIDE SOLUTIONS AT  $25^\circ$ . (Sherrill, 1903.)

Mols per Liter.		Gms. per Liter.	
KCN.	$Hg(CN)_2$	KCN.	$Hg(CN)_2$
0.0493	0.4855	3.21	122.6
0.0085	0.5350	6.41	135.2
0.1970	0.6270	12.83	158.4

The regularity of the increase in solubility proves that the complex  $Hg(CN)_3$  is formed at the given concentrations.Data are also given for the distribution of  $Hg(CN)_2$  between aqueous solutions of KCN and ether at  $25^\circ$ .SOLUBILITY OF MERCURIC CYANIDE IN AQUEOUS SOLUTIONS OF METHYL ALCOHOL, ETHYL ALCOHOL AND OF ETHYL ACETATE AT  $25^\circ$ . (Herz and Anders, 1907.)

In Aq. Methyl Alcohol.				In Aq. Ethyl Alcohol.				In Aq. Ethyl Acetate.			
Wt. % $CH_3OH$ in Solvent.	$d_{25}$ of Sat. Sol.	Gms. $Hg(CN)_2$ per 100 cc. Sat. Sol.		Wt. % $C_2H_5OH$ in Solvent.	$d_{25}$ of Sat. Sol.	Gms. $Hg(CN)_2$ per 100 cc. Sat. Sol.		Wt. % $CH_3COOC_2H_5$ in Solvent.	$d_{25}$ of Sat. Sol.	Gms. $Hg(CN)_2$ per 100 cc. Sat. Sol.	
10.6	1.0640	11.02		0	1.0813	10.95		0	1.0810	10.95	
30.77	1.0484	12.46		20.18	1.0339	8.76		4.39	1.0798	10.83	
47.06	1.0426	16.37		40.69	1.0006	9.02		96.76	1.0374	2.66	
64	1.0441	20.48		70.01	0.9419	9.57		100	0.9097	1.80	
78.05	1.0484	24.58		100	0.8552	8.19					
100	1.0762	34.29									

## SOLUBILITY OF MERCURIC CYANIDE IN ETHYL ALCOHOL, METHYL ALCOHOL AND IN MIXTURES OF THE TWO.

In Ethyl Alcohol.			In Methyl Alcohol.			In $CH_3OH + C_2H_5OH$ at $25^\circ$ .		
(Timofeiew, '94; de Bruyn, '92; Herz and Kuhn, 1908.)			(Dukelski, 1907.)			(Herz and Kuhn, 1908.)		
t°.	Gms. $Hg(CN)_2$ per 100 Gms. Sat. Sol.		t°.	Gms. $Hg(CN)_2$ per 100 Gms. Sat. Sol.		% $CH_3OH$ in Mixture.	$d_{25}$ of Sat. Sol.	Gms. $Hg(CN)_2$ per 100 cc. Sat. Sol.
0	8.3		0	26.10		4.37	0.8618	9.02
10	8.8		14.17	29.17		10.4	0.8707	10.10
20	9.25		23.4	32.01		41.02	0.9267	16.70
25	9.53*		27.4	31.77		80.69	1.024	28.20
30	9.8		31.7	32.53		84.77	1.034	29.60
40	10.3		38.1	33.29		91.25	1.052	30
* $d_{25} = 0.8552$			44.5	34.05		100	1.076	34.30

100 gms. of a sat. solution of  $Hg(CN)_2$  in a mixture of equimolecular amounts of  $CH_3OH$  and  $C_2H_5$  contain 10.2 gms.  $Hg(CN)_2$  at  $10^\circ$ , 13 gms. at  $30^\circ$  and 15 gms. at  $50^\circ$ . (Dukelski, 1907.)



TABLE OF MERCURIC CYANIDE IN MIXTURES OF PROPYL AND METHYL ALCOHOLS AND PROPYL AND ETHYL ALCOHOLS AT 25°. (Herz and Kuhn, 1908.)

In $C_3H_7OH + CH_3OH$ .				In $C_3H_7OH + C_2H_5OH$ .			
$d_{25}$ of Solvent.	$d_{25}$ of Sat. Sol.	Gms. $Hg(CN)_2$ per 100 cc. Sat. Sol.	% $C_3H_7OH$ in Mixed Solvent.	$d_{25}$ of Solvent.	$d_{25}$ of Sat. Sol.	Gms. $Hg(CN)_2$ per 100 cc. Sat. Sol.	
0.7878	1.0760	34.3	0	0.7867	0.8552	8.91	
0.7894	1.0327	29.52	8.1	0.7886	0.8549	7.90	
0.7907	0.9891	24.48	17.85	0.7902	0.8527	7.30	
0.7954	0.8800	10.48	56.6	0.7926	0.8386	5.21	
0.7992	0.8376	5.04	88.6	0.7973	0.8311	3.87	
0.7995	0.8335	4.23	91.2	0.7979	0.8306	3.84	
0.7999	0.8322	3.98	95.2	0.7986	0.8293	3.64	
0.8004	0.8283	3.44	100	0.8004	0.8283	3.44	

13. propyl alcohol dissolve 3.79 gms.  $Hg(CN)_2$  at 13.5°. (Timofeiew, 1894.)

14. acetonitrile (b. pt. 81.6°) dissolve 9.58 gms.  $Hg(CN)_2$  at 18°.

(Naumann and Schier, 1914.)

15. benzonitrile (b. pt. 190-1°) dissolve 1.093 gms.  $Hg(CN)_2$  at 18°.

(Naumann, 1914.)

SOLUBILITY OF MERCURIC CYANIDE IN ANILINE. (Staronka, 1910.)

Identification 41° 49 58.5 65 77 83.5 84 88.5  
 $Hg(CN)_2$  in sat.

on 3.7 5.7 7.7 9 14.2 18.2 19.7 23.4

liquid phases are the unstable  $Hg(CN)_2 \cdot 4C_6H_5NH_2$  and the stable  $Hg(CN)_2 \cdot 1/2$  (m. pt. about 90°).

16. sat. solution in ethyl ether contains 2.53 gms.  $Hg(CN)_2$  at 25°.

(Abegg and Sherrill, 1903.)

17. glycerol dissolve 27 gms.  $Hg(CN)_2$  at 15.5°.

PROPERTIES OF MERCURIC CYANIDE DOUBLE SALTS IN WATER AND IN ALCOHOL.

Soluble Salt.	t°.	Gms. per 100 Grams.		Observer.
		Water.	Alcohol.	
$2KCN$	cold	22.7	...	
$2TiCN$	1°	12.6	...	(Frommuller — Ber. 11, 92, '98.)
$2TiCN$	10°	9.7	...	"
$1/2 CaBr_2 \cdot 5H_2O$	cold	100.0	50.0	(Custer.)
$1/2 CaBr_2 \cdot 5H_2O$	boiling	400.0	100.0	"
$KCl \cdot H_2O$	18°	14.81	...	(Brett.)
$KBr \cdot 2H_2O$	18°	7.49	...	"
$KBr \cdot 2H_2O$	boiling	100.0+	...	"
$BaI_2 \cdot 4H_2O$	cold	6.42	4.42	(Custer.)
$BaI_2 \cdot 4H_2O$	boiling	250.0	62.5 (90% Alc.)	"
$KI$	cold	6.2	1.04 (34° B Alc.)	(Callot.)
$NaI_2 \cdot H_2O$	18°	22.2	15.4 (90% Alc.)	(Custer.)
$SrI_2 \cdot 6H_2O$	18°	14.3	25.0 (90% Alc.)	"

SOLUBILITY OF MERCURIC CYANIDE IN ORGANIC SOLVENTS AT 18°-20°.

(Salc, 1900.)

Solvent.	Formula.	G. $Hg(CN)_2$ per 100 Gms. Solvent.
Bromoform	$CHBr_3$	0.005
Carbon Tetra Chloride	$CCl_4$	0.001
Ethyl Bromide	$C_2H_5Br$	0.013
Ethylene Di Bromide	$C_2H_4Br_2$	0.001

or the ternary system, mercuric cyanide, phenol, water are given by Salc, 1907.



## SOLUBILITY OF MERCURIC CYANIDE IN PYRIDINE. (Staronka, 1910.)

Mols. Hg(CN) <sub>2</sub> per 100 Mols. Solid Phase.		Mols. Hg(CN) <sub>2</sub> per 100 Mols. Solid Phase.		Mols. Hg(CN) <sub>2</sub> per 100 Mols. Solid Phase.	
Hg(CN) <sub>2</sub> + C <sub>5</sub> H <sub>5</sub> N		Hg(CN) <sub>2</sub> + C <sub>5</sub> H <sub>5</sub> N		Hg(CN) <sub>2</sub> + C <sub>5</sub> H <sub>5</sub> N	
9	7.1	22.5	17.3	56.5	26.6
11	8.7	28.5	18.4	68	27.5
12.2	10.4	32	19.3	70	27.7
13	11.3	38	20.6	86	29
13.5	12.9	42	22.3	111	32
14.5	13.8	46	23.7	122.5	33.8
16.5	15.8	53	25.3	125	34.4
20.5	15.9	54.5	26	141	38.3

100 gms. pyridine dissolve 64.8 gms. Hg(CN)<sub>2</sub> at 18°. (Schroeder, 1911)

## SOLUBILITY OF MERCURIC CYANIDE IN QUINOLINE. (Staronka, 1910.)

Mols. Hg(CN) <sub>2</sub> per 100 Mols. Solid Phase.		Mols. Hg(CN) <sub>2</sub> per 100 Mols. Solid Phase.	
Hg(CN) <sub>2</sub> + C <sub>8</sub> H <sub>7</sub> N		Hg(CN) <sub>2</sub> + C <sub>8</sub> H <sub>7</sub> N	
45	4.2	137	13.2
54	6	161	17.4
89 (61°)	8.2	180	22.5
99 (61°)	9.2	192	27.1

MERCURY FULMINATE C<sub>2</sub>HgN<sub>2</sub>O<sub>2</sub>.

One liter of solution in water contains 0.70 gm. C<sub>2</sub>HgN<sub>2</sub>O<sub>2</sub> at 12° and 1 gm. at 49°. (Holleman, 1902.)

MERCURIC IODIDE HgI<sub>2</sub>.

## SOLUBILITY IN WATER.

t°.	Gms. HgI <sub>2</sub> per Liter.	Observer.
18	0.0004 (conductivity method)	(Kohlrausch, 1904-05.)
17.5	0.040	(Bourgoin, 1884.)
22	0.054	(Rohland, 1898.)
25	0.0591	(Morse, 1902.)

## SOLUBILITY OF MERCUROUS IODIDE IN WATER AT 25°. (Sherrill, 1903.)

One liter sat. solution contains  $2 \times 10^{-7}$  gms. Hg<sub>2</sub>I<sub>2</sub>, determined by indirect method.

Data for the solubility of mercurous iodide in aq. KI solutions at 25° are given by Sherrill.

## SOLUBILITY OF MERCURIC IODIDE IN AQUEOUS SOLUTIONS AT 25°.

(Herz and Paul, 1913.)

In Aq. BaI <sub>2</sub> .		In Aq. CaI <sub>2</sub> .		In Aq. NaI.		In Aq. SrI <sub>2</sub> .	
Mols. per Liter.		Mols. per Liter.		Mols. per Liter.		Mols. per Liter.	
BaI <sub>2</sub>	HgI <sub>2</sub>	CaI <sub>2</sub>	HgI <sub>2</sub>	NaI	HgI <sub>2</sub>	SrI <sub>2</sub>	HgI <sub>2</sub>
0.099	0.059	0.053	0.050	0.794	0.412	0.254	0.22
0.748	0.742	0.252	0.261	1.385	0.622	0.355	0.3
0.978	0.897	0.468	0.440	2.225	0.945	0.539	0.5
1.508	1.462	1.799	1.706			0.608	0.6

## SOLUBILITY OF MERCURIC IODIDE IN AQUEOUS SOLUTIONS OF POTASSIUM IODIDE AT 25°. (Sherrill, 1903; Herz and Paul, 1913.)

Mols. per Liter.		Gms. per Liter.		Mols. per Liter.		Gms. per Liter.	
KI.		KI.		KI.		KI.	
0.05	0.025	8.3	11.4	1	0.50	166	227.2
0.10	0.05	16.6	22.7	1.5	0.75	249	340.8
0.20	0.10	33.2	45.4	2	1	332	454.5
0.50	0.25	83	113.6	2.5	1.25	415	578

Data for the distribution of mercuric iodide between aq. KI solutions and benzene at 25° are given by Sherrill, 1903.



Equilibrium in the Ternary System Mercuric Iodide, Potassium Iodide, Water at 20° and 30°. (Dunningham 1914.)

Results at 20°.			Results at 30°.		
Gms. per 100 Gms. Sat. Sol.	HgI <sub>2</sub>	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	HgI <sub>2</sub>	Solid Phase.
9	19.3	KI	60.6	...	KI
1	32.4	"	40	53	" + KHgI <sub>2</sub>
1	48	"	39.6	52.7	KHgI <sub>2</sub>
1	53.6	" + KHgI <sub>2</sub>	40	52.2	"
1	52.6	KHgI <sub>2</sub>	40.2	51.2	"
1	52.2	"	39.3	50.3	"
1	51.2	KHgI <sub>2</sub> ·H <sub>2</sub> O	33.7	49.8	"
1	50.3	" + HgI <sub>2</sub>	33	52	"
1	49.4	HgI <sub>2</sub>	31.4	51.7	KHgI <sub>2</sub> ·H <sub>2</sub> O
1	40.2	"	29.1	52.2	"
1	22.5	"			

Equilibrium in the Ternary System Mercuric Iodide, Potassium Iodide, Ethyl Ether at 20°. (Dunningham, 1914.)

liquid layers with compositions as follows, are formed:

Gms. per 100 Gms. Upper Layer.		Gms. per 100 Gms. Lower Layer.		Solid Phase.
KI.	HgI <sub>2</sub> .	KI.	HgI <sub>2</sub> .	
1.1	2.8	None		KI + KHgI <sub>2</sub>
1.1	2.4	17.6	53.2	KHgI <sub>2</sub>
0.8	2.5	16.5	56.1	HgI <sub>2</sub>
None		17	58.2	KHgI <sub>2</sub> + HgI <sub>2</sub>

are also given for the four component system, HgI<sub>2</sub> + KI + (C<sub>2</sub>H<sub>5</sub>)<sub>2</sub>O + 20°. The results are of special interest since 3 liquid layers are formed.

Solubility of Mercuric Iodide in Aqueous Ethyl Alcohol:

At 18°.		At 25°.			
(Bourgoin.)		(Herz and Knoch — Z. anorg. Ch. 45, 266, '05.)			
Solvent.	Gms. HgI <sub>2</sub> per Liter.	Wt. % Alcohol in Solvent.	HgI <sub>2</sub> per 100 cc. Solution. Millimols.	Grams.	Sp. Gr. of Solutions 25°/4°
Alcohol	11.86	100	3.86	1.754	0.8033
+80% 90° Alc.	2.857	95.82	2.56	1.162	0.8095
+10% 90° Alc.	0.086	92.44	1.92	0.873	0.8154
		86.74	1.38	0.623	0.8300
		78.75	0.935	0.425	0.8465
		67.63	0.45	0.204	0.8721

Solubility of Mercuric Iodide in Aqueous Methyl Alcohol and in Aqueous Ethyl Acetate at 25°. (Herz and Anders, 1907.)

In Aq. Methyl Alcohol.				In Aq. Ethyl Acetate.		
<i>d</i> <sub>25</sub> of Solvent.	<i>d</i> <sub>25</sub> of Sat. Sol.	Gms. HgI <sub>2</sub> per 100 cc. Sat. Sol.	Wt. % CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub> in Solvent.	<i>d</i> <sub>25</sub> of Sat. Sol.	Gms. HgI <sub>2</sub> per 100 cc. Sat. Sol.	
0.9186	0.9187	0.044	4.36	0.9973	0.013	
0.8800	0.8834	0.158	96.74	0.9063	1.87	
0.8489	0.8519	0.445	100	0.9011	1.09	
0.7879	0.8155	2.590				

ns. sat. solution in 95% alcohol (*d*<sub>18</sub> = 0.8126) contain 0.72 gm. HgI<sub>2</sub> & 6 gms. at 25° and 2.15 gms. at 50°. (Reinders, 1900.)



## SOLUBILITY OF MERCURIC IODIDE IN ALCOHOLS.

Alcohol.	Formula.	t°.	Sp. Gr. of Solution.	Gms. HgI <sub>2</sub> per 100 Gms. Alcohol.	Observer
Methyl	CH <sub>3</sub> OH	15-20	0.799	3.24	(Rohland)
"	"	19	...	3.7	(Timofeev)
"	"	19.5	...	3.16	(de Braya)
"	"	23	...	3.98	(Beckmann)
"	"	66 (b. pt.)	...	6.512	(Salc.)
Ethyl	C <sub>2</sub> H <sub>5</sub> OH	15-20	0.810	1.42	(Rohland)
"	"	18	...	1.48	(Bourgeois)
"	"	19	...	1.86	(Timofeev)
"	"	19.5	...	2.09	(de Braya)
"	"	25	0.803	2.19	(Herz and Kuhn)
"	"	78 (b. pt.)	...	4.325	(Salc.)
Propyl	C <sub>3</sub> H <sub>7</sub> OH	15-20	0.816	0.826	(Rohland)
"	"	19	...	1.25	(Timofeev)
Amyl	C <sub>5</sub> H <sub>11</sub> OH	13	...	0.66	(Laszyński)
"	"	71	...	3.66	"
"	"	100	...	5.30	"
"	"	133.5	...	9.57	"
Isopropyl	(CH <sub>3</sub> ) <sub>2</sub> CH.OH	81 (b. pt.)	...	2.266	(Salc.)
Isobutyl	(CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> OH	22.5	...	0.51	(Timofeev)
"	"	105-107 (b. pt.)	...	2.433	(Salc.)

SOLUBILITY OF MERCURIC IODIDE IN MIXTURES OF ALCOHOLS AT 25°.  
(Herz and Kuhn, 1908.)

In CH <sub>3</sub> OH + C <sub>2</sub> H <sub>5</sub> OH.			In C <sub>2</sub> H <sub>5</sub> OH + CH <sub>3</sub> OH.			In C <sub>2</sub> H <sub>5</sub> OH + C <sub>2</sub> H <sub>5</sub> OH <sup>1</sup>		
Per cent CH <sub>3</sub> OH in Solvent.	d <sub>25</sub> of Sat. Sol.	Gms. HgI <sub>2</sub> per 100 cc. Sat. Sol.	Per cent C <sub>2</sub> H <sub>5</sub> OH in Solvent.	d <sub>25</sub> of Sat. Sol.	Gms. HgI <sub>2</sub> per 100 cc. Sat. Sol.	Per cent C <sub>2</sub> H <sub>5</sub> OH in Solvent.	d <sub>25</sub> of Sat. Sol.	Gms. HgI <sub>2</sub> per 100 cc. Sat. Sol.
0	0.8038	1.80	0	0.8156	3.16	0	0.8038	1.80
4.37	0.8039	1.93	11.11	...	...	8.1	0.8036	1.71
10.40	0.8046	2.08	23.80	0.8155	3.04	17.85	0.8043	1.6
41.02	0.8077	2.32	65.20	...	...	56.6	0.8057	1.5
80.69	0.8131	2.80	91.80	0.8101	1.69	88.6	...	...
84.77	0.8140	2.96	93.75	0.8110	1.67	91.2	0.8099	1.1
91.25	0.8146	2.98	96.60	0.8108	1.53	95.2	0.8108	1.1
100	0.8156	3.16	100	0.8116	1.42	100	0.8116	1.1

## SOLUBILITY OF MERCURIC IODIDE IN ACETONE IN ETHYL ACETATE AND IN BENZENE.

(Salc.; Krug and McElroy — J. Anal. Ch. 6, 186, '92; Laszyński — Ber. 27, 2285, '94.)

In Acetone.		In Ethyl Acetate.		In Benzene.	
t°.	Gms. HgI <sub>2</sub> per 100 Gms. (CH <sub>3</sub> ) <sub>2</sub> CO.	t°.	Gms. HgI <sub>2</sub> per 100 Gms. CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub> .	t°.	Gms. HgI <sub>2</sub> per 100 Gms. C <sub>6</sub> H <sub>6</sub> .
-1	2.83	-20	1.49	15	0.22
18	3.36	+17.5	1.56	60	0.88
25	2.09 (K. and McE.)	21	1.64	65	0.95
40	4.73	40	2.53	84	1.24
58	6.07	55	3.19	80 (b.pt.)	0.825 (S)
56 (b.pt.)	3.249 (Salc.)	76	4.31		

74-78 (b.pt.) 4.20 (Salc.)



acetone	dissolve 2.04 gms. $\text{HgI}_2$ at 23°.	(Beckmann and Stock, 1895.)
benzene	" 0.25 " " "	" "
chloroform	" 0.07 " " "	" "
acetone	" 2 " " (red) at 25°.	(Reinders, 1900.)
"	" 3.09 " " (yellow) at 25°.	" "
ethyl acetate	" 1.47 " " at 18°.	(Naumann, 1910.)

sat. solution in benzene contains 2.24 gms.  $\text{HgI}_2$  at 25°.  
(Abegg and Sherrill, 1903.)

#### SOLUBILITY OF MERCURIC IODIDE IN ANILINE.

(Pearce and Fry, 1914.)

Gms. $\text{HgI}_2$ per 100 Gms. Aniline.	Solid Phase.	t°.	Gms. $\text{HgI}_2$ per 100 Gms. Aniline.	Solid Phase.
...	$\text{C}_6\text{H}_5\text{NH}_2 + \text{HgI}_2 \cdot 2\text{C}_6\text{H}_5\text{NH}_2$	48.8	128.1	$\text{HgI}_2$ (red)
23.35	$\text{HgI}_2 \cdot 2\text{C}_6\text{H}_5\text{NH}_2$	63.6	163.8	"
28.69	"	70.82	184.1	"
42.85	"	76.2	201.6	"
47.55	"	95.9	246.7	"
55.47	"	108†	...	" + $\text{HgI}_2$ (yellow)
62.05	"	115.7	281.8	$\text{HgI}_2$ (yellow)
75.80	"	137.2	285.2	"
96.49	"	181.1	297.9	"
...	" + $\text{HgI}_2$ (red)	199.1	863.2	"

\* Eutec.

† Tr. pt.

all data on this system are also given by Staronka, 1910.  
the solubility of mercuric iodide in nitrobenzene and in *p* nitrotoluene,  
by the synthetic (sealed tube method), are given by Smits and Bak-  
er. The transition point of  $\text{HgI}_2$ , red to yellow, was found to be at  
per cent  $\text{HgI}_2$  and 127.5° in nitrobenzene and 1.81 mol. per cent  $\text{HgI}_2$   
in *p* nitrotoluene. The interesting part of the investigation is the  
the prolongation of the melting line above the transition point. Similar  
the solubility of mercuric iodide in nitrobenzene, *m* nitrotoluene, *p* nitro-  
d in nitronaphthalene, determined by the freezing-point method,  
ckmann apparatus, are given by Mascarelli (1906a). Observations  
variance and color changes of the  $\text{HgI}_2$  are given.

#### SOLUBILITY OF MERCURIC IODIDE IN CARBON DISULFIDE.

(Linebarger, 1894; Arctowski, 1894, 1895-96.)

Gms. $\text{HgI}_2$ per 100 Gms. Solution.	t°.	Gms. $\text{HgI}_2$ per 100 Gms. Solution.	t°.	Gms. $\text{HgI}_2$ per 100 Gms. Solution.
0.017	- 5	0.141	15	0.271
0.023	0	0.173	20	0.320
0.024	+ 5	0.207	25	0.382
0.107	10	0.239	30	0.445

sat. solution of mercuric iodide in  $\text{CS}_2$  contains 3.127 gms. at 15°.  
(Dawson, 1909b.)

sat. solution of mercuric iodide in  $\text{CCl}_4$  contains 0.170 gm. at 18°.  
(Dawson, 1909b.)

also given by Dawson for the distribution of  $\text{HgI}_2$  between aqueous  
KI and  $\text{CS}_2$  at 15° and aqueous solutions of KI and  $\text{CCl}_4$  at 18°.  
anhydrous hydrazine dissolve 69 gms.  $\text{HgI}_2$  with precipitation of Hg  
mp.  
(Welsh and Broderick, 1915.)



SOLUBILITY OF MERCURIC IODIDE IN SEVERAL ORGANIC SOLVENTS.  
(Sulc — Z. anorg. Ch. 25, 401, '00.)

Solvent.	Formula.	t°.	Gms. HgI <sub>2</sub> per 100 Gms. Solvent.
Chloroform	CHCl <sub>3</sub>	18–20	0.040
Chloroform	CHCl <sub>3</sub>	61 (b. pt.)	0.163
Bromoform	CHBr <sub>3</sub>	18–20	0.486
Tetra Chlor Methane	CCl <sub>4</sub>	18–20	0.006
Tetra Chlor Methane	CCl <sub>4</sub>	75 (b. pt.)	0.094
Ethyl Bromide	C <sub>2</sub> H <sub>5</sub> Br	18–20	0.643
Ethyl Bromide	C <sub>2</sub> H <sub>5</sub> Br	38° (b. pt.)	0.773
Ethylene Di Bromide	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	18–20	0.748
Ethyl Iodide	C <sub>2</sub> H <sub>5</sub> I	18–20	2.041
Ethylene Di Chloride	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	85.5° (b. pt.)	1.200
Iso Butyl Chloride	(CH <sub>3</sub> ) <sub>2</sub> CHCH <sub>2</sub> Cl	69	0.328
Methyl Formate	HCOOCH <sub>3</sub>	36–38	1.166
Ethyl Formate	HCOOC <sub>2</sub> H <sub>5</sub>	52–55	2.150
Methyl Acetate	CH <sub>3</sub> COOCH <sub>3</sub>	56–59	2.500
Acetal	CH <sub>3</sub> CH(OC <sub>2</sub> H <sub>5</sub> ) <sub>2</sub>	105	2.000
Epi Chlor Hydrine	CH <sub>2</sub> O.CH.CH <sub>2</sub> Cl	117	6.1 ± 3
Hexane	C <sub>6</sub> H <sub>14</sub>	67 ...	0.07 <sup>2</sup>

SOLUBILITY OF MERCURIC IODIDE IN ETHER AND IN METHYLENE IODIDE.

In Ether. (Sulc; Laszcynski.)		In Methylene Iodide. (Retgers — Z. anorg. Ch. 3, 253, '03.)	
t°.	Gms. HgI <sub>2</sub> per 100 Gms. (C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	t°.	Gms. HgI <sub>2</sub> per 100 Gms. CH <sub>2</sub> I <sub>2</sub> .
0	0.62	15	2.5
36	0.97	100	16.6
35 (b. pt.)	0.47 (Sulc)	180	58.0

SOLUBILITY OF MERCURIC IODIDE IN FATTY BODIES.

(Mehu — J. pharm. chim. [5] 12, 249, '85.)

Solvent.	t°.	Gms. HgI <sub>2</sub> per 100 Gms. Solvent.	Solvent.	t°.	Gms. HgI <sub>2</sub> per 100 Gms. Solvent.
Bitter Almond Oil	25	0.5	Vaseline	25	0.025
Bitter Almond Oil	100	1.3	Vaseline	100	0.20
Castor Oil	25	4.0	Poppy Oil	25	1.0
Castor Oil	100	20.0	Olive Oil	25	0.4
Nut Oil	100	1.3	Carbolic Acid	100	2.0

100 grams oil of bitter almonds dissolve 5.0 grams HgI<sub>2</sub>. KI at 15°.  
(Mehu.)

SOLUBILITY OF MERCURIC IODIDE IN OILS.

(Anon, 1903, 1904.)

OIL.	Gms. HgI <sub>2</sub> per 100 cc. Oil.	OIL.	Gms. HgI <sub>2</sub> per 100 cc. Oil.
Castor Oil	1.90	Peanut Oil	0.52
Walnut "	1.29	Olive "	0.45
Linseed "	1.23	Almond "	0.39
Cod Liver "	0.545	Vaseline	0.20



## SOLUBILITY OF MERCURIC IODIDE IN PYRIDINE.

Measurements from  $-50^{\circ}$  to  $98.5^{\circ}$  made by saturating the solvent at concentrations are given by Mathews and Ritter (1917). Measurements of solidification of various mixtures of the two components, covering from  $10^{\circ}$  to  $135^{\circ}$ , are given by Staronka (1910).

Gms. $\text{HgI}_2$ per 100 Gms. Solid Phase. Sat. Sol.		$t^{\circ}$ .	Gms. $\text{HgI}_2$ per 100 Gms. Solid Phase. Sat. Sol.	
1.93	$\text{HgI}_2 \cdot 2\text{C}_5\text{H}_5\text{N}$	90.08	61.43	$\text{HgI}_2 \cdot 2\text{C}_5\text{H}_5\text{N}$
4.27	"	100	65.72	"
10.28	"	105	68.89	"
14.85	"	107 m. pt.	72.09	"
18.42	"	105	75.67	"
24.40	"	100	79.73	"
27.90	"	90	84.16	"
37.64	"	87 Eutec.	85.17	" + $\text{HgI}_2 \cdot \text{C}_5\text{H}_5\text{N}$
43.15	"	100	86	$\text{HgI}_2 \cdot \text{C}_5\text{H}_5\text{N}$
48.29	"	120	87.16	"
57.60	"	135	88.78	"

SOLUBILITY OF MERCURIC IODIDE IN QUINOLINE.  
(Staronka, 1910.)

Mols. $\text{HgI}_2$ per 100 Mols. $\text{HgI}_2 + \text{C}_8\text{H}_7\text{N}$ .	Solid Phase.	$t^{\circ}$ .	Mols. $\text{HgI}_2$ per 100 Mols. $\text{HgI}_2 + \text{C}_8\text{H}_7\text{N}$ .	Solid Phase.
4.7	$\text{HgI}_2 \cdot 2\text{C}_8\text{H}_7\text{N}$	160	37.7	$\text{HgI}_2 \cdot \text{C}_8\text{H}_7\text{N}$
9.1	"	165	41.6	"
13.2	"	165	43	"
23.1	"	170	48.8	"
26.7	$\text{HgI}_2 \cdot \text{C}_8\text{H}_7\text{N}$	169.5	49.5	"
31.4	"	166.5	54.4	"

Point data for mixtures of  $\text{HgI}_2 + \text{I}$  are given by Olivari, 1908.

**(C) IODIDE** Diamine  $(\text{NH}_3)_2\text{HgI}_2$ .

The solubility of diamine mercuric iodide in aqueous ammonia solutions are given by Francois (1900). The solid is not stable in solutions less than 48 gms.  $\text{NH}_3$  per liter.

**(F) NITRATE** (ic)  $\text{Hg}(\text{NO}_3)_2$ , (ous)  $\text{Hg}_2(\text{NO}_3)_2$ .

anhydrous lanolin (m. pt. about  $46^{\circ}$ ) dissolve 1.15 gm.  $\text{Hg}(\text{NO}_3)_2$

(Klose, 1907.)

anhydrous hydrazine dissolve about 2 gms.  $\text{Hg}_2(\text{NO}_3)_2$  with precipitation at room temp.

(Welsh and Broderson, 1915.)

**(F) OXIDE**  $\text{HgO}$ .

## SOLUBILITY IN WATER.

(Schick, 1903.)

$t^{\circ}$ .	Gms. per 1000 cc. Solution.	
25	0.0518 yellow $\text{HgO}$	0.0513 red $\text{HgO}$
00	0.410 yellow $\text{HgO}$	0.379 red $\text{HgO}$

The mixtures were constantly agitated for 4 days or longer. At  $100^{\circ}$  they were boiled and stirred for 5 hours. A longer period would probably have given better agreement between the red and yellow  $\text{HgO}$ .

$\text{H}_2\text{O}$  dissolves 0.05 gm.  $\text{HgO}$  (red, large grains) at  $25^{\circ}$ . (Hulett, 1901.)

$\text{H}_2\text{O}$  dissolves 0.15 gm.  $\text{HgO}$  (red, finest grains) at  $25^{\circ}$ . "



SOLUBILITY OF MERCURIC OXIDE IN AQUEOUS HYDROFLUORIC ACID AT  
(Jaeger, 1901.)

Normality of HF.	Gms. Hg per 9.6 cc. Sat. Sol.	Gm. Atoms Hg per Liter.
0.12	0.0242	0.01258
0.24	0.0475	0.0247
0.57	0.1210	0.0629
1.11	0.2247	0.1168
2.17	0.4976	0.2586

MERCURY DIPHENYL  $\text{Hg}(\text{C}_6\text{H}_5)_2$ .

Fusion-point data for mixtures of  $\text{Hg}(\text{C}_6\text{H}_5)_2 + \text{Sn}(\text{C}_6\text{H}_5)_4$  are given by Cram (1912).

MERCURY SELENITE  $\text{HgSeO}_3$ .SOLUBILITY IN AQUEOUS SODIUM SELENITE SOLUTIONS AT 25°.  
(Rosenheim and Pritze, 1909.)

Normality of $\text{Na}_2\text{SeO}_3$ Solution.	Gms. $\text{HgSeO}_3$ per 100 Gms. Sat. Sol.	Normality $\text{Na}_2\text{SeO}_3$ of Solution.	Gms. $\text{HgSeO}_3$ per 100 Gms. Sat. Sol.
0.0625	0.18	0.5	0.70
0.125	0.32	1	1.39
0.25	0.53	2	2.73

MERCURY SULFATE (ic)  $\text{HgSO}_4$ .EQUILIBRIUM IN THE SYSTEM, MERCURY OXIDE, SULFUR TRIOXIDE, WATER  
(Hoitsema, 1895.)

Results expressed in molecules per sum of 100 molecules of the three components of the system. The mixtures were rotated for 3 hours or longer.

Results at 25°.

Results at 50°.

Liquid Phase.			Solid Phase.	Liquid Phase.			Solid Phase.
$\text{H}_2\text{O}$ .	$\text{SO}_3$ .	$\text{HgO}$ .		$\text{H}_2\text{O}$ .	$\text{SO}_3$ .	$\text{HgO}$ .	
98.5	1.24	0.33	$3\text{HgO} \cdot \text{SO}_3$	98.9	0.96	0.17	$3\text{HgO} \cdot \text{SO}_3$
96.6	2.49	0.92	"	96	3.05	0.93	"
94.4	3.93	1.65	"	93.2	4.92	1.90	"
93.9	4.24	1.85	$3\text{HgO} \cdot \text{SO}_3$ and	92.8	5.10	2.09	"
94.4	4.52	2.12	$3\text{HgO} \cdot 2\text{SO}_3 \cdot 2\text{H}_2\text{O}$	92.8	5.16	2.06	"
93.4	4.65	1.94	$3\text{HgO} \cdot 2\text{SO}_3 \cdot 2\text{H}_2\text{O}$	92.5	5.34	2.12	"
92.9*	4.81	2.29	$3\text{HgO} \cdot \text{SO}_3$	92.2	5.57	2.20	$3\text{HgO} \cdot \text{SO}_3$ and
92.9	5.11	1.98	$3\text{HgO} \cdot 2\text{SO}_3 \cdot 2\text{H}_2\text{O}$				$3\text{HgO} \cdot 2\text{SO}_3$
92.3*	5.20	2.54	$3\text{HgO} \cdot \text{SO}_3$	92.1	5.75	2.11	$3\text{HgO} \cdot 2\text{SO}_3$
92.3	5.58	2.09	$3\text{HgO} \cdot 2\text{SO}_3 \cdot 2\text{H}_2\text{O}$	92	5.80	2.16	"
92.1	5.81	2.08	"				
91.9	5.97	2.90	$3\text{HgO} \cdot \text{SO}_3$	91.2*	6.27	2.56	$3\text{HgO} \cdot \text{SO}_3$ and
91.9	6.15	2.05	$3\text{HgO} \cdot 2\text{SO}_3 \cdot 2\text{H}_2\text{O}$				$\text{HgO} \cdot \text{SO}_3$
91.3	6.54	2.13	"	91.5	6.34	2.19	$3\text{HgO} \cdot 2\text{SO}_3$ and
91.2	6.77	2.02	$\text{HgO} \cdot \text{SO}_3 \cdot \text{H}_2\text{O}$	91.3*	6.37	2.30	$\text{HgO} \cdot \text{SO}_3$
91.3	6.90	1.80	"	91.6	6.69	1.75	"
91.3	7.67	1.01	"	91.1	8.32	0.57	"
91.3	7.84	0.89	$\text{HgO} \cdot \text{SO}_3 \cdot \text{H}_2\text{O}$ and	90.5	9.11	0.4	"
91	8.36	0.69	$\text{HgO} \cdot \text{SO}_3$	89.6	10.2	0.23	"
90.5	8.95	0.53	"	86.7	13.2	0.06	"
89.2	10.6	0.22	$\text{HgO} \cdot \text{SO}_3$	31.6	68.4	0.03	"
75.8	24.2	trace	"				
39.2	60.7	trace	"				

\* Indicates unstable equilibrium



**MERCUROSUS SULFATE**  $\text{Hg}_2\text{SO}_4$ .

**SOLUBILITY IN WATER, IN SULFURIC ACID AND IN POTASSIUM SULFATE AT 25°.**  
(Drucker, 1901; Wright and Thomson, 1884-85; Wilsomore, 1900.)

Solvent.	$\text{Hg}_2\text{SO}_4$ per Liter.	
	Gm. Mol.	Gms.
Water	11.71 $10^{-4}$	0.58 (0.47 W. and T., 0.39 W.)
Aq. $\text{H}_2\text{SO}_4$ (1.96 gms. per liter)	8.31 "	0.41
Aq. $\text{H}_2\text{SO}_4$ (4.90 gms. per liter)	8.78 "	0.44
Aq. $\text{H}_2\text{SO}_4$ (9.80 gms. per liter)	8.04 "	0.40
Aq. $\text{K}_2\text{SO}_4$ (34.87 gms. per liter)	9.05 "	0.45

**SOLUBILITY OF MERCUROSUS SULFATE IN WATER AT DIFFERENT TEMPERATURES.**  
(Barre, 1911.)

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	$\text{Hg}_2\text{SO}_4$	$\text{H}_2\text{SO}_4$	
16.5	0.055	0.008	$\text{Hg}_2\text{SO}_4$
33	0.060	0.018	"
50	0.065	0.037	"
75	0.074	0.063	"
100	0.092	0.071	"

The mixtures were kept at constant temp. but not constantly agitated. By successive treatment of a given amount of  $\text{Hg}_2\text{SO}_4$  with  $\text{H}_2\text{O}$ , it is gradually converted to an almost insoluble basic salt,  $\text{Hg}_2\text{O} \cdot \text{Hg}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ .

**SOLUBILITY OF MERCUROSUS SULFATE IN AQUEOUS POTASSIUM SULFATE SOLUTIONS.** (Barre, 1911.)

Results at 15°.			Results at 33°.			Results at 75°.		
Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
$\text{K}_2\text{SO}_4$	$\text{Hg}_2\text{SO}_4$	$\text{H}_2\text{SO}_4$ (free).	$\text{K}_2\text{SO}_4$	$\text{Hg}_2\text{SO}_4$	$\text{H}_2\text{SO}_4$ (free).	$\text{K}_2\text{SO}_4$	$\text{Hg}_2\text{SO}_4$	$\text{H}_2\text{SO}_4$ (free)
2.90	0.0475	0.0080	2.94	0.0677	0.0250	3.10	0.1344	0.1684
5.70	0.0703	0.0093	5.68	0.1015	0.0350	5.75	0.2120	0.2135
8.22	0.0912	0.0098	8.30	0.1364	0.0441	8.50	0.2951	0.2514
8.77	0.0994	...	10.70	0.1724	0.0438	13.20	0.4610	0.2503
9.44	0.1080	0.0110	11.90	0.1902	0.0420	17.30	0.6440	0.2225

**MERCURY SULFIDE**  $\text{HgS}$ .

One liter  $\text{H}_2\text{O}$  dissolves  $0.054 \times 10^{-4}$  mols.  $\text{HgS}$  = 0.0000125 gm. at 18°.  
(Weigel, 1906, 1907. See also Bruner and Zawadzki.)

**Hexamethyl MELLITIC ACID Ester**  $\text{C}_6(\text{COOCH}_3)_6$ .

Data for the ternary system hexamethyl mellitic acid ester, phenol and water are given by Timmermans (1907).

**MENTHOL**  $\text{C}_{10}\text{H}_{18}\text{OH}$ .

One cc. of 95% alcohol dissolves about 5 gms. menthol at room temp.  
(Greenish and Smith, 1903.)

**FREEZING-POINT DATA** (Solubility, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES.

Menthol + Ethylene bromide	(Dahms, 1895.)
" + Menthane	(Vanstone, 1909.)
" + Methyl urethan	(Scheuer, 1910.)
" + Naphthalene	"
" + <i>p</i> Toluidine	(Pawlewski, 1893.)

**SOLIDIFICATION POINTS OF MIXTURES OF MENTHOL AND SALOL.** (Bellucci, 1912, 1913.)

t° of Solidification	42	30.5	28	28.5	32.5	41.9
Gm. Salol per 100 Gm. Mixture	100	80	60	40	20	0



# METHANE

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## METHANE CH<sub>4</sub>.

### SOLUBILITY IN WATER.

(Winkler, 1901.)

t°.	β.	β'.	q.	t°.	β.	β'.	q.
0	0.05563	0.05530	0.00396	40	0.02369	0.02198	0.00159
5	0.04805	0.04764	0.00341	50	0.02134	0.01876	0.00136
10	0.04177	0.04127	0.00296	60	0.01954	0.01571	0.00115
15	0.03690	0.03628	0.00260	70	0.01825	0.01265	0.00093
20	0.03308	0.03233	0.00232	80	0.01770	0.00944	0.00070
25	0.03006	0.02913	0.00209	90	0.01735	0.00535	0.00040
30	0.02762	0.02648	0.00191	100	0.01700	0	0

For the values of β, β' and q see Ethane, page 285.

### SOLUBILITY OF METHANE IN METHYL ALCOHOL AND IN ACETONE.

(Levi, 1901, 1902.)

In methyl alcohol *l* (Ostwald expression, see page 227) = 0.5644 - 0.0046 *t* - 0.00004 *t*<sup>2</sup>.

In acetone *l* (Ostwald expression) = 0.5906 - 0.00613 *t* - 0.000046 *t*<sup>2</sup>.

From which are calculated the following values:

In Methyl Alcohol.				In Acetone.			
t°.	<i>l</i> .	t°.	<i>l</i> .	t°.	<i>l</i> .	t°.	<i>l</i> .
0	0.5644	40	0.3164	0	0.5906	40	0.2718
10	0.5144	50	0.2344	10	0.5247	50	0.1691
20	0.4564	60	0.1444	20	0.4496	60	0.0572
30	0.3904	70	0.0464	30	0.3653		

### SOLUBILITY OF METHANE IN SEVERAL ALCOHOLS AND OTHER SOLVENTS.

(McDaniel, 1911.)

Solvent.	t°.	Abs. Coef. A.	Bunsen Coef. β.	Solvent.	t°.	Abs. Coef. A.	Bunsen Coef. β.
Alcohol:							
Methyl (99%)	22.1	0.4436	0.4102	Toluene	40.1	0.4675	0.4080
"	30.2	0.4278	0.3883	"	50.2	0.4545	0.4013
"	40	0.3938	0.3436	"	60	0.4502	0.3690
"	49.8	0.2695	0.2278	<i>m</i> Xylene	21.1	0.5146	0.4778
Ethyl (99.8%)	22.2	0.4628	0.4282	"	30.5	0.5028	0.4520
"	30.1	0.4503	0.4051	"	50	0.4972	0.4203
"	40	0.4323	0.3771	"	60	0.4870	0.3902
Isopropyl	21.5	0.4620	0.4275	Hexane	22.2	0.6035	0.5585
"	29.9	0.4532	0.4081	"	40.2	0.5320	0.4639
"	40	0.4400	0.3837	"	49.7	0.5180	0.4380
"	60.3	0.4244	0.3478	"	60	0.4964	0.4068
Amyl	22	0.4532	0.4196	Heptane	22.2	0.7242	0.6720
"	30.1	0.4444	0.4002	"	30.1	0.6906	0.6221
Benzene	22.1	0.4954	0.4600	"	40	0.6675	0.5820
"	35	0.4484	0.3976	Pinene*	20	0.4888	0.4565
"	40.1	0.4198	0.3661	"	30.1	0.4620	0.4163
"	49.9	0.3645	0.3081	"	39.1	0.4472	0.3914
Toluene	25	0.4852	0.4450	"	45	0.4440	0.3811
"	30	0.4778	0.4300	"	55.2	0.3694	0.3076

\* b. pt. 155-160°.

Abs. coef. A = vol. of methane absorbed by unit vol. of solvent at ~~temp.~~ stated.

For definition of Bunsen abs. coef. β see carbon dioxide, p. 227.



## SOLUBILITY OF METHANE IN ETHYL ALCOHOL.

(Bunsen, 1877, 1892.)

t°.	2°.	6.4°.	11°.	15°.	19°.	23.5°.
coef. $\beta$ (found)	0.51721	0.50382	0.49264	0.48255	0.4729	0.4629

which the following formula was calculated.

sen abs. coef.  $\beta$  for methane =  $0.522745 - 0.00295882 t - 0.0000177 t^2$ .  
 solubility of methane in aq.  $H_2SO_4$  (Christoff, 1906) in terms of the Ostwald  
 ity expression  $l_{20}$ . In 95.6%  $H_2SO_4$ ,  $l_{20} = 0.03303$ ; in 61.62%  $H_2SO_4$ ,  
 0.01407; in 35.82%  $H_2SO_4$ ,  $l_{20} = 0.01815$ ; in  $H_2O$ ,  $l_{20} = 0.03756$ .  
 solubility of methane in ethyl ether, in terms of the Ostwald Solubility  
 sion  $l$  (see p. 227), is 1.066 at 0° and 1.028 at 10°. (Christoff, 1912.)  
 coef. of absorption  $\beta$  (Bunsen) of methane in petroleum (Russian) is 0.144  
 and 0.131 at 20°. (Gniiewoz and Walfisz, 1887.)  
 ion-point data are given for diphenyl methane + naphthalene by Miolati,  
 and for diphenyl methane + phenol by Paterno and Ampola (1897).

nyl **METHANE**  $CH(C_6H_5)_3$ .

## SOLUBILITY IN ANILINE.

(Hartley and Thomas, 1906.)

synthetic method, see page 16.

Gms. $CH(C_6H_5)_3$ per 100 Gms. So- lution.	Mol. per cent $CH(C_6H_5)_3$ .	Solid Phase.	t°.	Gms. $CH(C_6H_5)_3$ per 100 Gms. So- lution.	Mol. per cent $CH(C_6H_5)_3$ .	Solid Phase.
5.4	1.85	$CH(C_6H_5)_3 \cdot C_6H_5NH_2$ rhombs	71.3	67.9	44.6	$CH(C_6H_5)_3 \cdot C_6H_5NH_2$ rhombs
9.5	3.8	"	71.6	71.7	49.1	"
13.5	5.6	"	71.2	76.3	55.1	"
21.9	9.7	"	70.6	78.3	57.9	"
36.5	17.8	"	71.6	82.1	63.5	$CH(C_6H_5)_3$ monoclinic
47.2	25.4	"	74.3	84.9	68.2	"
54.8	31.6	"	82.1	91.7	80.9	"
64.6	40.9	"	87.3	96.1	90.2	"

## SOLUBILITY OF TRI PHENYL METHANE IN BENZENE.

Linebarger — Am. Ch. J. 15, 45, '93.)

(Hartley and Thomas.)

Gms. $CH(C_6H_5)_3$ per 100 Grams $C_6H_6$ .	Solid Phase.	t°.	Gms. $CH(C_6H_5)_3$ per 100 Gms. Solution.	Mol. per cent $CH(C_6H_5)_3$ .	Solid Phase.
9	$C_6H_6 + CH(C_6H_5)_3 \cdot C_6H_6$	33	12.6	4.4	$CH(C_6H_5)_3 \cdot C_6H_6$ rhombs
0	$CH(C_6H_5)_3 \cdot C_6H_6$	49.4	24.0	8.8	"
5	"	65.6	38.9	17.2	"
1	"	73.8	57.5	30.2	"
4	"	77.1	67.4	39.7	"
1	"	77.9	76.3	50.7	"
5	$(C_6H_5)_3CH \cdot C_6H_6$ + $CH(C_6H_5)_3$	77.5	80.2	56.4	"
0	$CH(C_6H_5)_3$	76.2	84.1	62.8	"
6	"	74.6	87.5	69.1	$CH(C_6H_5)_3$ monoclinic
1	"	76.0	89.0	72.2	"
5	"	78.8	90.5	75.3	"
0	"	82.3	93.1	81.3	"
2	"	86.6	95.7	87.8	"

rtley and Thomas call attention to the inaccuracy of Linebarger's results and  
 e correctness of the determinations of Kuriloff (1897a). According to  
 of the tr. pt.  $(C_6H_5)_3CH \cdot C_6H_6 + C_6H_6$  is at 4.2° and 1.25 mol. %  $(C_6H_5)_3CH$ .  
 .pt. of  $(C_6H_5)_3CH \cdot C_6H_6$  is 78.2° and the tr. pt.  $(C_6H_5)_3CH \cdot C_6H_6 + (C_6H_5)_3CH$   
 14° and 69.4 mol. %  $(C_6H_5)_3CH$ .



## SOLUBILITY OF TRI PHENYL METHANE IN CARBON BISULPHIDE.

(Etard — Ann. chim. phys. [7] 2, 570, '94; below  $-80^{\circ}$ , Arctowski — Z. anorg. Ch. 11, 273, '95.

t°.	Gms. $\text{CH}(\text{C}_6\text{H}_5)_3$ per 100 Gms. Solution.	t°.	Gms. $\text{CH}(\text{C}_6\text{H}_5)_3$ per 100 Gms. Solution.	t°.	Gms. $\text{CH}(\text{C}_6\text{H}_5)_3$ per 100 Gms. Solution.
-113.5	0.98	-40	7.5	40	63.7
-102	1.24	-20	13.7	50	72.4
-91	1.56	0	25.8	60	78.6
-83	1.91	+10	38.7	70	85.6
-60	3.4	20	43.2	80	92.2
		30	52.9		

## SOLUBILITY OF TRI PHENYL METHANE IN HEXANE AND IN CHLOROFORM. (Etard.)

t°.	Gms. $\text{CH}(\text{C}_6\text{H}_5)_3$ per 100 Gms. Solution in:		t°.	Gms. $\text{CH}(\text{C}_6\text{H}_5)_3$ per 100 Gms. Solution in:	
	Hexane.	Chloroform.		Hexane.	Chloroform.
-50	...	10.5	30	12.5	48.8
-30	1.2	15.2	40	20.0	56.1
-20	1.6	19.0	50	25.8	63.8
-10	2.2	23.5	60	45.7	71.7
0	3.5	28.9	70	62.0	79.8
+10	5.6	35.0	80	78.5	87.2
20	8.3	41.5	90	97.0	...

## SOLUBILITY OF TRI PHENYL METHANE IN:

(Hartley and Thomas.)

Pyttrole.				Thiophene.			
t°.	Gms. $\text{CH}(\text{C}_6\text{H}_5)_3$ per 100 Gms. Sol.	Mol. per cent $\text{CH}(\text{C}_6\text{H}_5)_3$ .	Solid Phase.	t°.	Gms. $\text{CH}(\text{C}_6\text{H}_5)_3$ per 100 Gms. Solution.	Mol. per cent $\text{CH}(\text{C}_6\text{H}_5)_3$ .	Solid Phase.
24.6	24.3	8.1	$\text{CH}(\text{C}_6\text{H}_5)_3 \cdot \text{C}_6\text{H}_5\text{NH}$ rhombs	25.7	26.0	10.8	$\text{CH}(\text{C}_6\text{H}_5)_3$
29.0	29.8	10.4	"	33.5	31.1	13.5	"
31.5	33.4	12.1	"	44.0	43.6	21.1	"
36.8	40.6	15.8	$\text{CH}(\text{C}_6\text{H}_5)_3$ monoclinic	47.6	48.4	24.4	"
42.7	49.1	20.9	"	53.5	58.7	32.9	"
46.9	56.0	25.9	"	57.4	70.2	44.7	"
53.2	63.9	32.8	"	57.6	74.8	50.6	"
60.0	72.3	41.8	"	62.7	78.7	56.0	$\text{CH}(\text{C}_6\text{H}_5)_3$ mono
63.9	76.7	47.4	"	67.0	81.9	60.8	"
68.5	81.9	55.6	"	67.2	82.1	61.3	"
71.1	84.4	59.8	"	74.2	87.4	70.5	"
80.0	91.5	74.8	"	79.0	90.3	76.3	"
89.2	97.6	91.8	"	87.2	96.2	89.9	"

F-pt. data for triphenylmethane + naphthalene are given by Vignon (18)

## SOLUBILITY OF TRIPHENYL METHANE IN PYRIDINE. (Hartley and Thomas, 19

Synthetic method used, see note, p. 16.

t°.	Gms. $\text{CH}(\text{C}_6\text{H}_5)_3$ per 100 Gms. Solution.	Mol. per cent $\text{CH}(\text{C}_6\text{H}_5)_3$ .	Solid Phase.	t°.	Gms. $\text{CH}(\text{C}_6\text{H}_5)_3$ per 100 Gms. Solution.	Mol. per cent $\text{CH}(\text{C}_6\text{H}_5)_3$ .	Solid P.
22.8	46.2	22	$\text{CH}(\text{C}_6\text{H}_5)_3$	59.3	75.6	50.3	$\text{CH}(\text{C}_6\text{H}_5)_3$
31.7	53.3	27.2	" monoclinic	67.8	81.9	59.7	"
37.9	57.6	30.7	"	72.8	85.7	66.4	"
48.7	66.6	39.5	"	80.6	91.5	77.2	"
53.1	70.1	43.5	"	86.8	95.8	88.1	"



## Ethyl and Methyl Sulfon METHANES.

## SOLUBILITY IN WATER AND IN 90% ALCOHOL.

Compound.	Formula.	t°	Gms. Cmpd. per 100 cc.:		Authority.
			Water.	90% Alcohol	
Sulfonal $(\text{CH}_3)_2\text{C}(\text{SO}_2\text{C}_2\text{H}_5)_2$		15.5	0.22	1.25	(Greenish and Smith, 1903.)
Tetronal $(\text{C}_2\text{H}_5)_2\text{C}(\text{SO}_2\text{C}_2\text{H}_5)_2$		15-20	0.18	8.33	(Squire and Caines, 1905.)
Trional $(\text{CH}_3)(\text{C}_2\text{H}_5)\text{C}(\text{SO}_2\text{C}_2\text{H}_5)_2$		15-20	0.31	9.0	" " "

## DISTRIBUTION BETWEEN WATER AND OLIVE OIL AT ROOM TEMP.

(Baum, 1899; Meyer, 1909.)

Compound.	Formula.	Gms. Cmpd. per 100 cc.		Ratio (o) (w)
		H <sub>2</sub> O Layer (w).	Oil Layer (o).	
Dimethyl Sulfon Dimethyl Methane $(\text{CH}_3)_2\text{C}(\text{SO}_2\text{CH}_3)_2$		0.6072	0.0622	0.103
Diethyl Sulfon Methane $\text{CH}_2(\text{SO}_2\text{C}_2\text{H}_5)_2$		0.610	0.092	0.151
Sulfonal $(\text{CH}_3)_2\text{C}(\text{SO}_2\text{C}_2\text{H}_5)_2$		0.070	0.0686	0.979
Trional $(\text{CH}_3)(\text{C}_2\text{H}_5)\text{C}(\text{SO}_2\text{C}_2\text{H}_5)_2$		0.0404	0.1646	4.074
Tetronal $(\text{C}_2\text{H}_5)_2\text{C}(\text{SO}_2\text{C}_2\text{H}_5)_2$		0.0462	0.1446	3.756

METHYL ACETATE  $\text{CH}_3\text{COOCH}_3$ .100 gms.  $\text{H}_2\text{O}$  dissolve 25 gms.  $\text{CH}_3\text{COOCH}_3$  at 22°.

(Traube, 1884.)

More recent data for the solubility of this compound in water are given by (Herz, 1917).

METHYL ALCOHOL  $\text{CH}_3\text{OH}$ .

## FREEZING-POINTS OF MIXTURES OF METHYL ALCOHOL AND WATER.

(Pickering, 1893; Baumé and Borowski, 1914.)

t°.	Gms. $\text{CH}_3\text{OH}$ per 100 Gms. Sol.	Solid Phase.	t°.	Gms. $\text{CH}_3\text{OH}$ per 100 Gms. Sol.	Solid Phase.	t°.	Gms. $\text{CH}_3\text{OH}$ per 100 Gms. Mixtures.	Solid Phase.
-10	14.5	Ice	-70	58.3	Ice	-130	75.5	Ice
-20	25	"	-80	62.6	"	-138.5	77	" + $\text{CH}_3\text{OH}$
-30	33	"	-90	65.7	"	-130	82	$\text{CH}_3\text{OH}$
-40	40	"	-100	68.8	"	-120	86.5	"
-50	47	"	-110	71.5	"	-110	92	"
-60	52.6	"	-120	74.0	"	-95.7	100	"

In the vicinity of the eutectic the solutions become vitreous and direct determinations of the f.-pt. cannot be made. The above results were obtained from the curve.

## MISCIBILITY OF METHYL ALCOHOL (see Note, p. 287) AT 0° WITH MIXTURES OF:

Carbon Tetrachloride and Water. (Bonner, 1910.) Chloroform and Water. (Bonner, 1910.)  
Composition of Homogeneous Mixtures.

Gms. $\text{CCl}_4$	Gms. $\text{H}_2\text{O}$	Gms. $\text{CH}_3\text{OH}$	Sp. Gr. of Mixture.	Gms. $\text{CHCl}_3$	Gms. $\text{H}_2\text{O}$	Gms. $\text{CH}_3\text{OH}$	Sp. Gr. of Mixture.
0.985	0.015	0.215	...	0.979	0.021	0.161	...
0.974	0.026	0.328	1.30	0.90	0.10	0.35	1.17
0.90	0.10	0.74	1.13	0.80	0.20	0.49	1.12
0.80	0.20	1.10	1.04	*0.73	0.27	0.57	...
0.70	0.30	1.40	1	0.70	0.30	0.60	1.08
0.60	0.40	1.68	0.97	0.60	0.40	0.70	1.05
0.50	0.50	1.71	0.95	0.50	0.50	0.77	1.02
0.40	0.60	1.77	0.93	0.40	0.60	0.83	1
0.30	0.80	1.88	0.92	0.20	0.80	0.84	0.97
0.20	0.90	1.90	0.92	0.10	0.90	0.74	0.96
0.10	0.90	1.90	0.92	0.10	0.90	0.74	0.96
0.026	0.974	1.045	0.93	0.013	0.987	0.267	0.98



## MISCIBILITY OF METHYL ALCOHOL (see Note, p. 287) AT 0° WITH MIXTURES OF:

## Brombenzene and Water. (Bonner, 1910.)

## Ethyl Bromide and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.				Composition of Homogeneous Mixtures.			
Gms. C <sub>6</sub> H <sub>5</sub> Br.	Gms. H <sub>2</sub> O.	Gms. CH <sub>3</sub> OH.	Sp. Gr. of Mixture.	Gms. C <sub>2</sub> H <sub>5</sub> Br.	Gms. H <sub>2</sub> O.	Gms. CH <sub>3</sub> OH.	Sp. Gr. of Mixture.
0.991	0.009	0.230	...	0.973	0.027	0.202	1.27
0.985	0.015	0.314	1.24	0.950	0.05	0.33	...
*0.98	0.02	0.40	...	0.936	0.064	0.393	1.18
0.90	0.10	1.01	1.04	0.90	0.10	0.54	1.14
0.80	0.20	1.50	0.98	0.80	0.20	0.86	1.05
0.70	0.30	1.84	0.95	0.70	0.30	1.04	1.01
0.60	0.40	2.065	0.94	0.60	0.40	1.18	0.99
0.50	0.50	2.24	0.91	0.50	0.50	1.26	0.97
0.40	0.60	2.30	0.90	0.40	0.60	1.31	0.96
0.30	0.70	2.28	0.89	0.20	0.80	1.21	0.94
0.20	0.80	2.20	0.89	0.10	0.90	0.94	0.94
0.095	0.905	1.927	0.90	0.022	0.978	1.94	0.98
0.016	0.984	1.332	0.91				

## MISCIBILITY OF METHYL ALCOHOL (see Note, p. 287) AT 0° WITH MIXTURES OF:

## Hexane and Water. (Bonner, 1910.)

## Heptane and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.				Composition of Homogeneous Mixtures.			
Gms. Hexane(1).	Gms. H <sub>2</sub> O.	Gms. CH <sub>3</sub> OH.	Sp. Gr. of Mixture.	Gms. Heptane(1).	Gms. H <sub>2</sub> O.	Gms. CH <sub>3</sub> OH.	Sp. Gr. of Mixture.
0.973	0.067	4.280	...	0.966	0.034	4.78	...
0.90	0.10	4.69	0.80	0.90	0.10	5.55	0.80
0.80	0.20	5.26	0.80	0.793	0.207	6.36	0.82
0.691	0.309	5.710	0.82	0.70	0.30	7.30	0.82
0.60	0.40	6.17	0.81	0.60	0.40	8.22	0.82
0.491	0.509	6.365	0.83	0.50	0.50	8.76	0.82
0.40	0.60	6.33	0.83	0.40	0.60	8.65	0.83
0.30	0.70	6.13	0.84	0.30	0.70	7.78	0.83
0.20	0.80	5.49	0.85	0.198	0.802	6.71	0.84
0.10	0.90	4.01	0.86	0.10	0.90	4.40	0.87
0.016	0.984	1.759	0.91	0.038	0.962	2.96	0.91

(1) The hexane and heptane used were Kahlbaum's "aus Petroleum."

100 cc. cotton seed oil ( $d_{25} = 0.922$ ) dissolve 4.84 gms. CH<sub>3</sub>OH at 25°.

100 cc. methyl alcohol dissolve 6.74 gms. cotton seed oil at 25°. (Wroth and Reid, 1916.)

## DISTRIBUTION OF METHYL ALCOHOL BETWEEN WATER AND COTTON SEED OIL AT 25°. (Wroth and Reid, 1916.)

Gms. CH <sub>3</sub> OH per 100 cc.			Ratio.	Gms. CH <sub>3</sub> OH per 100 cc.			Ratio.
Oil Layer.	H <sub>2</sub> O Layer.			Oil Layer.	H <sub>2</sub> O Layer.		
0.199	17.28		86.6	0.275	23.48		85.2
0.253	23.34		92.2	0.258	24.44		94
0.298	25.73		86.2	0.284	23.06		81.4
0.264	24.15		91.3				

Freezing-point curves (solubility, see footnote, p. 1) are given for the following mixtures: CH<sub>3</sub>OH + SO<sub>2</sub>, CH<sub>3</sub>OH + C<sub>2</sub>H<sub>5</sub>COOH, (CH<sub>3</sub>OH.HCl) + C<sub>2</sub>H<sub>5</sub>COOH, (C<sub>2</sub>H<sub>5</sub>COOH.HCl) + CH<sub>3</sub>OH (Baumé and Pamfil, 1914); CH<sub>3</sub>OH + NH<sub>3</sub> (Baumé and Borowski, 1914); CH<sub>3</sub>OH + CH<sub>3</sub>I (Baumé and Tykociner, 1914).



**METHYL AMINES**  $\text{CH}_3\text{NH}_2$ ,  $(\text{CH}_3)_2\text{NH}$ ,  $(\text{CH}_3)_3\text{N}$ .

Freezing-point data (solubility, see footnote, p. 1) for mixtures of  $\text{CH}_3\text{NH}_2 + \text{H}_2\text{O}$ ,  $(\text{CH}_3)_2\text{NH} + \text{H}_2\text{O}$  and  $(\text{CH}_3)_3\text{N} + \text{H}_2\text{O}$  are given by Pickering (1893).

The solubility of methylamine and of dimethylamine in water at  $60^\circ$ , calculated from the vapor pressures determined by an aspiration method are given by Doyer (1890) as follows:

Amine.	Vapor Pressure in mm. Hg.	Ostwald Solubility Coef. <i>l.</i> (see p. 227).	Bunsen Abs. Coef. <i>\beta</i> . (see p. 327).
$\text{CH}_3\text{NH}_2$	40.6	511	419
$(\text{CH}_3)_2\text{NH}$	90.3	230	188

**SOLUBILITY OF TRIMETHYL AMINE IN VARIOUS SOLVENTS AT  $25^\circ$ .**

(v. Halban, 1913.)

The measurements were made according to the dynamic method in the form developed by R. Abegg and his collaborators (Gaus, 1900; Abegg and Riesenfeld, 1902). The calculations of the partial pressures of the trimethylamine were made according to the Abegg and Riesenfeld method.

$E$  = calc. partial pressure of  $(\text{CH}_3)_3\text{N}$  above a 1 normal solution, based on Henry's Law.

$\lambda$  = solubility, *i.e.*, the quotient of the concentration in the solution and in the gas phase:  $\lambda = \frac{\text{mols. } (\text{CH}_3)_3\text{N per liter} \times RT \times 760}{\text{partial pressure of } (\text{CH}_3)_3\text{N in mm. Hg}}, RT \times 760 = 18,590.$

Solvent.	<i>E.</i>	$\lambda$ .	Solvent.	<i>E.</i>	$\lambda$ .	Solvent.	<i>E.</i>	$\lambda$ .
Methyl Alc.	26.1	711	Acetophenone	321	57.9	Ethyl Acetate	220	84.5
Ethyl "	39.5	471	Ether	349	53.3	Ethyl Benzoate	244	76.2
Propyl "	39.4	472	Acetonitrile	292	63.7	Chloroform	31.1	598
Amyl "	48.3	385	Nitromethane	329	56.5	$\alpha$ Bromnaphthalene	409	47
Benzyl "	14.2	1308	<i>o</i> Nitrotoluene	340	54.7	Hexane	248	75
Acetone	243	76.7	Nitrobenzene	350	53.1	Benzene	172	109

Two determinations are also given for triethyl amine:

$\lambda_{25}$  in hexane = 2160.  $\lambda_{25}$  in nitromethane = 400.

**METHYL AMINE AND TRI METHYL AMINE, DISTRIBUTION BETWEEN:****Water and Amyl Alcohol.**

(Herz and Fischer — Ber. 37, 4751, '04.)

Gms. $\text{NH}_3(\text{CH}_3)$ per 100 cc.		Millimols $\text{NH}_3(\text{CH}_3)$ per 10 cc.	
Aq. Layer.	Alcoholic Layer.	Aq. Layer.	Alcoholic Layer.
0.37	0.12	1.155	0.3804
0.94	0.33	3.036	1.070
1.57	0.54	5.054	1.759
1.89	0.69	6.083	2.219
2.00	0.72	6.429	2.315
2.53	0.92	8.126	2.981
3.30	1.24	10.613	3.974

**Water and Benzene.**

(Herz and Fischer — Ber. 38, 1143, '05.)

Gms. $\text{N}(\text{CH}_3)_3$ per 100 cc.		Millimols $\text{N}(\text{CH}_3)_3$ per 10 cc.	
Aq. Layer.	$\text{C}_6\text{H}_6$ Layer.	Aq. Layer.	$\text{C}_6\text{H}_6$ Layer.
0.345	0.174	0.584	0.295
0.812	0.396	1.377	0.670
1.075	0.545	1.819	0.921
1.462	0.731	2.474	1.237
2.139	1.077	3.619	1.823
2.757	1.376	4.663	2.328
3.292	1.683	5.568	2.847
3.906	2.053	6.760	3.474
6.582	3.465	11.135	5.861



**DISTRIBUTION OF METHYLAMINE BETWEEN WATER AND CHLOROFORM AND DIMETHYL AND TRIMETHYL AMINES BETWEEN WATER AND TOLUENE.**  
(Moore and Winnill, 1912.)

Amine.	Results at 18°.		Results at 25°.		Results at 32.35°.	
	Gm. Equiv. per Liter Aq. Layer.	Partition Coef.	Gm. Equiv. per Liter Aq. Layer.	Partition Coef.	Gm. Equiv. per Liter Aq. Layer.	Partition Coef.
(CH <sub>3</sub> )NH <sub>2</sub>	0.0817	8.496	0.1203	7.965	0.1399	5.99
"	0.0809	8.477	0.1312	8	0.0959	6
(CH <sub>3</sub> ) <sub>2</sub> NH	0.0759	23.28	0.1203	19.013	0.1003	13.38
"	0.0975	23.29	0.1010	19.05	0.1043	13.36
(CH <sub>3</sub> ) <sub>3</sub> N	0.0688	3.297	0.0677	2.291	0.1182	1.815
"	0.0791	3.290	0.0641	2.297	0.1248	1.820

Similar data for the distribution of trimethylamine between water and toluene at 25° and at other temperatures are given by Hantzsch and Sebalt (1899) and Hantzsch and Vagt (1901).

**DIMETHYL AMINE HYDROCHLORIDE** (CH<sub>3</sub>)<sub>2</sub>NH.HCl.

100 gms. H<sub>2</sub>O dissolve 369.2 gms. (CH<sub>3</sub>)<sub>2</sub>NH.HCl at 25°. (Peddle and Turner, 1915.)  
100 gms. CHCl<sub>3</sub> dissolve 16.91 gms. (CH<sub>3</sub>)<sub>2</sub>NH.HCl at 25°. " "

**Phenyl METHYL AMINE HYDROCHLORIDE** (CH<sub>3</sub>)(C<sub>6</sub>H<sub>5</sub>)NH.HCl.

100 gms. H<sub>2</sub>O dissolve 378.8 gms. (CH<sub>3</sub>)(C<sub>6</sub>H<sub>5</sub>)NH.HCl at 25°. (Peddle and Turner, 1915.)

**Di and TriMETHYL AMINE CHLOROPLATINATES, (CH<sub>3</sub>)<sub>2</sub>NH.H<sub>2</sub>PtCl<sub>6</sub> (CH<sub>3</sub>)<sub>3</sub>N.H<sub>2</sub>PtCl<sub>6</sub>.**

**SOLUBILITY OF EACH IN AQ. ALCOHOL AT 0°. (Bertheaume, 1930.)**

Solvent.	Gms. Each Compound (Determined Separately) per 100 Gms. Solvent.	
	(CH <sub>3</sub> ) <sub>2</sub> NH.H <sub>2</sub> PtCl <sub>6</sub> .	(CH <sub>3</sub> ) <sub>3</sub> N.H <sub>2</sub> PtCl <sub>6</sub> .
Absolute Alcohol	0.0048	0.0036
90°	"	0.110
80°	"	0.070
70°	"	0.325
60°	"	0.243
	0.558	0.391
	0.996	0.766

**METHYL BUTYRATE** C<sub>3</sub>H<sub>7</sub>COOCH<sub>3</sub>.

100 gms. H<sub>2</sub>O dissolve 1.7 gms. C<sub>3</sub>H<sub>7</sub>COOCH<sub>3</sub> at 22°. (Traube, 1884.)

More recent data for the solubility of methyl butyrate in water are given by Herz, 1917.

**METHYL BUTYRATE, METHYL VALERATE.**

**SOLUBILITY OF EACH IN AQUEOUS ALCOHOL MIXTURES.**

(Bancroft, 1895; from Pfeiffer, 1892.)

100 cc. H<sub>2</sub>O dissolve 1.15 cc. methyl butyrate at 20°.

cc. Alcohol in Mixture.	cc. H <sub>2</sub> O Added.*		cc. Alcohol in Mixture.	cc. H <sub>2</sub> O Added.*
	Butyrate.	Valerate.		Valerate.
3	2.34	1.66	27	44.15
6	6.96	5.06	30	52.37
9	12.62	9.03	33	62.25
12	19.45	13.40	36	74.15
15	28.13	18.41	39	91.45
18	38.80	24	42	∞
21	55.64	30.09		
24	∞	36.72		

\* cc. H<sub>2</sub>O added to cause the separation of a second phase in mixtures of the given amounts of ethyl alcohol and 3 cc. portions of methyl butyrate and of methyl valerate respectively.

**METHYL ETHER** (CH<sub>3</sub>)<sub>2</sub>O.

F.-pt. curves are given for (CH<sub>3</sub>)<sub>2</sub>O + H<sub>2</sub>O (Baumé and Perrot, 1914); (CH<sub>3</sub>)<sub>2</sub>O + C<sub>2</sub>H<sub>5</sub>, (CH<sub>3</sub>)<sub>2</sub>O + SO<sub>2</sub> (Baumé, 1914); (CH<sub>3</sub>)<sub>2</sub>O + NO (Baumé and Germann, 1914); (CH<sub>3</sub>)<sub>2</sub>O + CO<sub>2</sub> (Baumé and Borowski, 1914).



**METHYL IODIDE**, Methylene Chloride and Methylene Bromide.

SOLUBILITY OF EACH IN WATER. (Rex, 1906.)

°.	Gms. per 100 Gms. H <sub>2</sub> O.		
	CH <sub>3</sub> I.	CH <sub>2</sub> Cl <sub>2</sub> .	CH <sub>2</sub> Br <sub>2</sub> .
0	1.565	2.363	1.173
10	1.446	2.122	1.146
20	1.419	2	1.148
30	1.429	1.969	1.176

Fusion-point data for methyl iodide + pyridine are given by Aten (1905-06).

**METHYL ORANGE** H<sub>2</sub>NC<sub>6</sub>H<sub>4</sub>.N<sub>3</sub>.C<sub>6</sub>H<sub>4</sub>SO<sub>3</sub>Na.

100 gms. H <sub>2</sub> O	dissolve	0.02 gm. methyl orange at 20-25°.	(Dehn, 1917.)
pyridine	"	1.80 "	" "
aq. 50% pyridine	"	51.5 "	" "

**METHYL OXALATE** (CH<sub>3</sub>)<sub>2</sub>C<sub>2</sub>O<sub>4</sub>.

100 gms. H <sub>2</sub> O	dissolve	6.18 gms. (CH <sub>3</sub> ) <sub>2</sub> C <sub>2</sub> O <sub>4</sub> at 20-25°.	(Dehn, 1917.)
pyridine	"	4.8 "	" "
aq. 50% pyridine	"	93.1 "	" "
95 % formic acid	"	22.58 "	at 20.2° (Aschan, 1913.)

F.-pt. data for (CH<sub>3</sub>)<sub>2</sub>C<sub>2</sub>O<sub>4</sub> + H<sub>2</sub>O are given by Skrabal (1917).**METHYLENE BLUE** (CH<sub>3</sub>)<sub>2</sub>N.C<sub>6</sub>H<sub>3</sub>(NS).C<sub>6</sub>H<sub>3</sub>:N(CH<sub>3</sub>)<sub>2</sub>Cl.

100 gms. H <sub>2</sub> O	dissolve	4.36 gms. methylene blue at 20-25°.	(Dehn, '17.)
pyridine	"	0.26 "	" "
aq. 50% pyridine	"	0.74 "	" "

Data for the distribution of methylene blue between aniline and water are given by Pelet-Jolivet (1909).

**METHYL PROPIONATE** C<sub>2</sub>H<sub>5</sub>COOCH<sub>3</sub>.100 gms. H<sub>2</sub>O dissolve 5 gms. C<sub>2</sub>H<sub>5</sub>COOCH<sub>3</sub> at 22°. (Traube, 1884.)

More recent data for the solubility of methyl propionate in water are given by Herz (1917).

**METHYL SALICYLATE** C<sub>6</sub>H<sub>4</sub>OH.COOCCH<sub>3</sub>.100 cc. H<sub>2</sub>O dissolve 0.074 gm. C<sub>6</sub>H<sub>4</sub>OH.COOCCH<sub>3</sub> at 30°. (Gibbs, 1908.)100 cc. 0.1 N H<sub>2</sub>SO<sub>4</sub> dissolve 0.077 gm. C<sub>6</sub>H<sub>4</sub>OH.COOCCH<sub>3</sub> at 30°.

## SOLUBILITY OF METHYL SALICYLATE IN AQUEOUS ALCOHOL AT 25°. (Seidell, 1910.)

Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	d <sub>m</sub> of Sat. Sol.	Gms. C <sub>6</sub> H <sub>4</sub> OH- COOCCH <sub>3</sub> per 100 Gms. Sat. Sol.	Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	d <sub>m</sub> of Sat. Sol.	Gms. C <sub>6</sub> H <sub>4</sub> OH- COOCCH <sub>3</sub> per 100 Gms. Sat. Sol.
0	1	0.12	60	0.923	18.60
30	0.958	0.60	65	0.929	30.50
40	0.940	2.30	70	0.943	39.40
50	0.925	6.20	75	0.974	58.50
55	0.922	10	80	1.050	72

## SOLUBILITY OF METHYL SALICYLATE IN AQUEOUS ALCOHOL AT DIFFERENT TEMPERATURES. (Seidell, 1910.)

Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	Gms. C <sub>6</sub> H <sub>4</sub> OH.COOCCH <sub>3</sub> per 100 cc. Solvent at:			
	15°.	20°.	25°.	30°.
0	(about) 0.1	0.1	0.1	0.1
30	0.3	0.4	0.5	0.6
40	0.8	1.1	1.4	1.8
50	2.4	3.5	5	6
55	4.2	6	7.8	9.5
60	7.7	10	12.5	15.5
65	13	16.5	20.2	24.5
70	22	28	33	40
75	43	52	62	72
80	92	135	180	230



**METHYL SULFATE**  $(\text{CH}_3)_2\text{SO}_4$ .

## RECIPROCAL SOLUBILITY OF METHYL SULFATE AND OIL OF TURPENTINE.

The determinations were made by the synthetic method (sealed tubes).

The  $d_{25}$  of the oil of turpentine,  $\text{C}_{10}\text{H}_{16}$ , was 0.8602, its absolute index of refraction for yellow light at  $25^\circ$  was 1.467 and its rotation in a 100-mm. tube was  $-32.25^\circ$ .

t°.	Gms. $(\text{CH}_3)_2\text{SO}_4$ per 100 Gms.		t°.	Gms. $(\text{CH}_3)_2\text{SO}_4$ per 100 Gms.	
	$(\text{CH}_3)_2\text{SO}_4$ Rich Layer.	$\text{C}_{10}\text{H}_{16}$ Rich Layer.		$(\text{CH}_3)_2\text{SO}_4$ Rich Layer.	$\text{C}_{10}\text{H}_{16}$ Rich Layer.
30	95	4	80	87	13
40	93	5	90	84	17
50	92	6	100	76	27
60	91	8	105	68	37
70	89	10	108.2 (crit. t.)	50.5	

The results are influenced appreciably by the age and purity of the product and by the length of time the mixtures are kept in the sealed tubes. Somewhat different results were obtained with a sample of turpentine containing 5 vol. % white spirit.

**MICHLER'S KETONE** (Tetramethyl-p<sub>2</sub>-diamidobenzophenone)  $\text{CO}[\text{C}_6\text{H}_4\text{N}(\text{CH}_3)_2]_2$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 0.04 gm. of ketone at  $20-25^\circ$ . (Dehn, 1903.)  
 " pyridine " 9.92 " " " "  
 " aq. 50% pyridine " 3.59 " " " "

**MOLYBDENUM TRIOXIDE** (Molybdic acid dihydrate)  $\text{MoO}_3 \cdot 2\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER. (Rosenheim and Berthelm, 1903.)

t°.	Gms. $\text{MoO}_3$ per 1000 Gms.		t°.	Gms. $\text{MoO}_3$ per 1000 Gms.	
	Sat. Solution.	$\text{H}_2\text{O}$ .		Sat. Solution.	$\text{H}_2\text{O}$ .
18	1.065	1.066	59	10.117	11.258
23	1.822	1.856	60	10.760	12.057
30	2.570	2.638	66	14.730	17.274
40	4.541	4.761	70	17.048	20.550
48	5.980	6.360	74.4	17.290	20.904
50.2	6.431	6.873	75	17.300	20.920
54	7.283	7.855	79	17.400	21.064

When a solution of the dihydrate is held at  $40-50^\circ$ , considerable amounts of crystals, designated by the authors as  $\alpha$  molybdic acid monohydrate, separate. These differ from the  $\beta$  molybdic acid monohydrate obtained by direct conversion of dihydrate at  $70^\circ$ , in being better crystals and in yielding solutions which can be filtered.

SOLUBILITY OF  $\alpha$  MOLYBDIC ACID MONOHYDRATE IN WATER.  
(Rosenheim and Davidsohn, 1903.)

t°.	Gms. $\text{MoO}_3$ per 1000 Gms.		t°.	Gms. $\text{MoO}_3$ per 1000 Gms.	
	Sat. Solution.	$\text{H}_2\text{O}$ .		Sat. Solution.	$\text{H}_2\text{O}$ .
14.8	2.112	2.117	45	3.648	3.661
24.6	2.612	2.619	52	4.167	4.184
30.3	2.964	2.973	60	4.665	4.685
36.8	3.284	3.295	70	4.213	4.231
42	3.434	3.446	80	5.185	5.212

## SOLUBILITY OF MOLYBDIC ACID DIHYDRATE IN AQ. AMMONIUM SALT SOLUTIONS. (R. and D., 1903.)

t°.	Solvent.	Gms. $\text{MoO}_3$ per 1000 Gms.	
		Sat. Solution.	Solvent.
29.6	10% $(\text{NH}_4)_2\text{SO}_4$	18.91	19.27
31.5	10% $\text{NH}_4\text{HSO}_4$	26.79	27.53
41.8	"	33.22	34.36
49.7	"	36.32	37.60

Fusion-point data for  $\text{MoO}_3 + \text{Na}_2\text{MoO}_4$  are given by Groschuff (1908).



**INE**  $C_{17}H_{19}NO_3 \cdot H_2O$ .

**SOLUBILITY IN SEVERAL SOLVENTS.**

(U. S. P.; Müller, W., 1903.)

At.	Gms. Morphine per 100 Gms. Solution.			Solvent.	Gms. Morphine per 100 Gms. Solution.	
	At 18°-22°.	At 25°.	At 80°.		At 18°-22°.	At 25°.
	0.0283	0.030	0.0061	Chloroform	0.0655	0.0555
	...	0.600	1.31 (60°)	Amyl Alcohol	...	0.8810
	0.0131	0.0224	...	Ethyl Acetate	0.1861	0.1905
with	0.0094	...	...	Petroleum		
				Ether	0.0854	...
with				Carbon Tetra-		
	0.0447	...	...	chloride	0.0156	0.032 (17°)
	0.0625	...	...	Glycerol	0.45 (15.5°)	...
	0.0254 (20°)	(Winterstein, 1909.)		CCl <sub>4</sub>	0.025 (20°)	(Gori, 1913.)
	0.0504 (20°)	"		Aniline	6.1 (20°)	(Scholtz, 1912.)
	0.0288 (15°)	(Guerin, 1913.)		Pyridine	16 (20°)	"
	0.128 (15°)	"		Piperidine	39.8 (20°)	"
1. %				Diethylamine	7.41 (20°)	"
	0.132 (15°)	"		50% Aq.	5.2 (r. temp.) { (Baroni and Barlinetto, 1911.)	
	0.0217 (20°)	(Zalai, 1910.)		Glycerol +		
	0.0192 (20°)	(Guild, 1907.)		3% H <sub>3</sub> BO <sub>3</sub>		

**SOLUBILITY OF MORPHINE IN SEVERAL SOLVENTS AT 25°.**

(Schaefer, 1913.)

Solvent.	Gms. $C_{17}H_{19}NO_3 \cdot H_2O$ per 100 cc. Solvent.	Solvent.	Gms. $C_{17}H_{19}NO_3 \cdot H_2O$ per 100 cc. Solvent.
Alcohol	0.388	1 Vol. $C_2H_5OH$ + 4 Vols. $CHCl_3$	0.66
yl Alcohol	6.66	" + 4 Vols. $C_6H_6$	0.2
oform	0.04	1 Vol. $CH_3OH$ + 4 Vols. $CHCl_3$	4.54
ne	insol.	" + 4 Vols. $C_6H_6$	2.5

**SOLUBILITY OF MORPHINE IN ETHYL ETHER AT 5.5°.**

(Marchionneschi, 1907.)

Solvent.	Gms. Morphine per 100 Gms. Sat. Sol.	Solid Phase.
and Distilled Ether	0.049	$C_{17}H_{19}NO_3 \cdot H_2O$
Purified by Distillation over Na	0.263	"
" " "	0.56	$C_{17}H_{19}NO_3$

**ITY OF MORPHINE IN AQUEOUS SOLUTIONS OF SALTS AND BASES AT ROOM TEMPERATURE, SHAKEN EIGHT DAYS.**

(Dieterich, 1890.)

or Base.	In N/10 Salt or Base.		In N/1 Salt or Base.	
	Grams per Liter.		Grams per Liter.	
	Salt or Base.	Morphine.	Salt or Base.	Morphine.
OH	3.51	0.20	35.08	0.505
$(NH_4)_2CO_3$	4.80	0.031	48.03	0.040
H	4.62	2.78	46.16	...
O <sub>2</sub>	6.92	0.20	69.15	0.379
CO <sub>2</sub>	10.02	0.024	100.16	0.040
OH	4.00	3.33	40.05	...
CO <sub>2</sub>	5.30	0.09	53.03	0.14
HCO <sub>2</sub>	8.41	0.032	84.06	0.044
OH <sub>2</sub> (sat.)	...	1.00 (25°)	...	...



# MORPHINE

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**MORPHINE ACETATE**  $\text{CH}_3\text{COOH} \cdot \text{C}_{17}\text{H}_{19}\text{NO}_3 \cdot 3\text{H}_2\text{O}$ , Morphine Hydrochloride  $\text{HCl} \cdot \text{C}_{17}\text{H}_{19}\text{NO}_3 \cdot 3\text{H}_2\text{O}$ , Morphine Sulphate  $\text{H}_2\text{SO}_4 \cdot (\text{C}_{17}\text{H}_{19}\text{NO}_3)_2 \cdot 5\text{H}_2\text{O}$ , and Apo Morphine Hydrochloride  $\text{HO} \cdot \text{C}_{17}\text{H}_{17}\text{NO}_3$ .

## SOLUBILITY IN SEVERAL SOLVENTS.

(U. S. P.)

Solvent.	Grams per 100 Grams of Solvent.							
	Acetate.		Hydrochloride.		Sulphate.		Apo M. Hydrochloride.	
	25°.	80°.	25°.	80°.	25°.	80°.	25°.	80°.
Water	44.9	50.0	5.81	200.0	6.53	166.6	2.53	6.25
Alcohol	4.6	40.0*	2.4	2.8*	0.22	0.53*	2.62	3.33
Chloroform	0.21	...	...	...	...	...	0.026	...
Ether	...	...	...	...	...	...	0.053	...
Glycerine	19.2	...	20.0†	...	...	...	...	...

\* 60°.

† 15.5°.

100 gms.  $\text{H}_2\text{O}$  dissolve 1.69 gms. apo morphine hydrochloride at 15.5°, and 2.04 gms. at 25°.

100 gms. 90% alcohol dissolve 1.96 gms. apo morphine hydrochloride at about 15.5°.

100 gms.  $\text{H}_2\text{O}$  dissolve 4.17 gms. morphine hydrated sulfate  $\cdot 5\text{H}_2\text{O}$  at 15°.

(Dott, 1904.)

(Power, 1884.)

## MORPHINE SALTS (con.)

### SOLUBILITY IN WATER AND IN 90% ALCOHOL AT ORD. TEMP.

(Squire and Caines, 1905.)

Morphine Salt.	Gms. Salt per 100 cc.		Morphine Salt.	Gms. Salt per 100 cc.	
	$\text{H}_2\text{O}$ .	90% Alcohol.		$\text{H}_2\text{O}$ .	90% Alcohol.
Morphine Acetate	...	1	Diacetyl Morphine (Heroin)	0.11	2.5
" Hydrochloride	...	2	" HCl	50	9.1
" Sulfate	...	0.143	Ethyl Morphine HCl (Dionin)	14.3	20
" Tartrate	10	0.172			

100 gms. 4%  $\text{HClO}_4$  solution dissolve 0.44 gm. morphine perchlorate at 15°.

(Hofmann, Roth, Höbald and Metzler, 1910.)

### SOLUBILITY OF MORPHINE SALTS IN SEVERAL SOLVENTS AT 25°.

(Schaeffer, 1913.)

Gms. of Each Salt Separately per 100 cc. of Each Solvent.

Solvent.	Gms. of Each Salt Separately per 100 cc. of Each Solvent.				
	Morphine Hydrochloride.	Morphine Sulfate.	Diacetyl Morphine.	Diacetyl Morphine HCl.	Ethyl Morphine HCl.
95% Ethyl Alcohol	0.606	0.2	3	9.1	4
85% Ethyl Alcohol	1.2	0.4	...	...	...
80% Ethyl Alcohol	2	0.77	...	...	...
Methyl Alcohol	...	...	4	11.1	66.6
Chloroform	Insol.	Insol.	66.6	33.3	0.526
Benzene	Insol.	Insol.	12.5	Insol.	Insol.
1 Vol. $\text{C}_2\text{H}_5\text{OH}$ + 4 Vols. $\text{CHCl}_3$	0.18	0.0164	66.6	4.5	5
" + 4 Vols. $\text{C}_6\text{H}_6$	0.089	0.0133	25	0.71	1.14
1 Vol. $\text{CH}_3\text{OH}$ + 4 Vols. $\text{CHCl}_3$	...	0.22	66.6	20	20
" + 4 Vols. $\text{C}_6\text{H}_6$	0.253	0.066	25	6.6	8.33

Ethyl **MORPHINE**  $\text{C}_{17}\text{H}_{17}\text{ON}(\text{OH})(\text{OC}_2\text{H}_5)$ .

100 cc.  $\text{H}_2\text{O}$  dissolve 0.208 gm.  $\text{C}_{17}\text{H}_{17}\text{ON}(\text{OH})(\text{OC}_2\text{H}_5)$  at 25°.

" alcohol " 1.33 gms. " " " " " "

" ether " 66.6 " " " " " "

(Schaeffer, 1912.)



**Ethyl MORPHINE HYDROCHLORIDE**  $C_{17}H_{17}NO(OH)(OC_2H_5).HCl.2H_2O$   
(Dionin) (see also on preceding page).

**SOLUBILITY IN WATER AND IN ALCOHOL.** (Schaeffer, 1912.)

t°.	Gms. Ethyl Morphine HCl per 100 cc.	
	Water.	Alcohol.
15	8.7	3.85
25	12.5	5
40	25	12.1
50	40	20

These results differ from similar data for commercial samples of Dionin. The differences are believed to be due to the impurities (amorphous salts of the by-products of the ethylation) in commercial products.  
100 cc.  $H_2O$  dissolve 10 gms. ethyl morphine hydrochloride at ord. temp. (Dott, 1912.)

**MUSTARD OIL** Allyl Isothiocyanate Ester  $CS:NC_3H_5$ .

**SOLUBILITY IN SULFUR BY SYNTHETIC METHOD.** (See Note, p. 16.)  
(Alexejew, 1886.)

t°.	Gms. Mustard Oil per 100 Gms.	
	Sulfur Layer.	Mustard Oil Layer.
90	10	72
100	12	67
110	15	62
120	23	51
124 (crit. temp.)		35

Freezing-point data for allyl isothiocyanate + aniline are given by Kurnakov and Solovev (1916). Results for methyl isothiocyanate + phenanthrene and methyl isothiocyanate + naphthalene are given by Kurnakov and Efrenov (1912).

**MYRISTIC ACID**  $C_{14}H_{27}COOH$ .

**SOLUBILITY IN ALCOHOLS.** (Timofeiew, 1894.)

Alcohol.	t°.	Gms. $C_{14}H_{27}COOH$ per 100 Gms. Sat. Sol.	Alcohol.	t°.	Gms. $C_{14}H_{27}COOH$ per 100 Gms. Sat. Sol.
Methyl Alcohol	0	2.81	Propyl Alcohol	0	5.6
" "	21	21.2	" "	21	31.2
" "	31.5	59.2	" "	36.5	55.3
Ethyl Alcohol	0	7.14	Isobutyl Alcohol	0	6.4
" "	21	31	" "	21	28

Freezing-point data for myristic acid + palmitic acid are given by Heintz (1854).

**NAPHTHALENE**  $C_{10}H_8$ .

1000 cc.  $H_2O$  dissolve 0.019 gm.  $C_{10}H_8$  at 0° and 0.030 gm. at 25°. (Hilpert, 1916)

**SOLUBILITY IN ACETIC AND OTHER ACIDS.** (Timofeiew, 1894.)

Acid.	t°.	Gms. $C_{10}H_8$ per 100 Gms. Acid.	Acid.	t°.	Gms. $C_{10}H_8$ per 100 Gms. Acid.
Acetic Acid	6.75	6.8	Isobutyric Acid	6.75	12.3
" "	21.5	13.1	Propionic Acid	6.75	13.9
" "	42.5	31.1	" "	21.5	23.4
" "	51.3	53.5	" "	50	79.8
" "	60	111	Valeric Acid	6.75	9.5
Butyric Acid	6.75	13.6	" "	21.5	17.7
" "	21.5	22.1	" "	65	167.4
" "	60	131.6			



SOLUBILITY OF NAPHTHALENE IN AQUEOUS AMMONIA.  
(Hilpest, 1916.)

Solvent,	Gms. $C_{10}H_8$ per 1000 Gms. Solvent at:	
	0°.	25°.
Aq. 5% $NH_3$	0.030	0.044
Aq. 10% $NH_3$	0.042	0.074
Aq. 25% $NH_3$	0.064	0.162
100% $NH_3$	33	120
Aq. 2% Pyridine	0.082	0.245

SOLUBILITY IN METHYL, ETHYL, AND PROPYL ALCOHOLS.

(Speyers—Am. J. Sci. [4] 14, 204, '02; at 19.5°, de Bruyn—Z. physik. Chem. 10, 784, '92; at 11°  
few—Compt. rend. 112, 1137, '91.)

The original results were calculated to a common basis, plotted on cross-section paper, and the following table read from the curves.

t°.	In Methyl Alcohol.		In Ethyl Alcohol.		In Propyl Alcohol.	
	Wt. of 1 cc. Solution.	Gms. $C_{10}H_8$ per 100 Gms. $CH_3OH$ .	Wt. of 1 cc. Solution.	Gms. $C_{10}H_8$ per 100 Gms. $C_2H_5OH$ .	Wt. of 1 cc. Solution.	Gms. $C_{10}H_8$ per 100 Gms. $C_3H_7OH$ .
0	0.8194	3.48	0.8175	5.0	0.8285	4.45
10	0.812	5.6	0.814	7.0	0.824	5.6
20	0.807	8.2	0.810	9.8	0.821	8.2
25	0.805	9.6	0.809	11.3	0.820	9.6
30	0.804	11.2	0.809	13.4	0.820	11.4
40	0.805	16.2	0.812	19.5	0.823	16.4
50	0.813	26.0	0.822	35.0	0.837	26.0
60	0.837	50.0	0.855	67.0	0.867	50.0
65	0.870	...	0.890	96.0	0.897	80.0
70	0.9023 (68°)	...	0.930	179.0	0.933	134.1 (68°)

EQUILIBRIUM IN THE SYSTEM NAPHTHALENE, ACETONE, WATER.  
(Cady, 1898.)

An excess of naphthalene was added to each of a series of mixtures of water acetone and the temperature determined at which a second liquid phase appeared. Since an excess of naphthalene was present, the amount dissolved not known. The following supplementary experiment was, therefore, required to ascertain the composition of the saturated solution in each case. "A weighed quantity of naphthalene was added to a known weight of the mixed liquids, amount being just sufficient to cause the formation of two liquid phases. The consolute temperature of the system was then determined and the experiment repeated several times with different amounts of naphthalene. If the results plotted, using the weights of naphthalene in a constant quantity of the mixed liquids as abscissas and the temperatures as ordinates, we shall get a series of curves. The composition of the liquid phase at the moment when the system passes from solid, solution and vapor to solid, two solutions and vapor is given by the point at which the prolongation of the curve for that particular mixture of acetone and water, cuts the ordinate for temperature at which the change takes place. This method requires no analysis and is of advantage in this case where ordinary quantitative analysis would be very difficult." Considerable difficulty was experienced in determining the consolute temperatures. It was necessary on account of the extreme volatility of the acetone to seal the mixtures in tubes.

The table of results, calculated with the aid of the determinations made as described above, is given on the following page.



BE SHOWING THE TEMPERATURES AT WHICH SOLUTIONS OF THE GIVEN COMPOSITIONS BEGIN TO SEPARATE INTO TWO LAYERS IN PRESENCE OF SOLID NAPHTHALENE.

(Cady, 1898.)

(Calculated as described on preceding page.)

t°.	Gms. per 100 Gms. Solution.		
	Acetone.	Water.	Naphthalene.
65.5	10	89.92	0.08
53.3	19.91	80	0.09
45	29.92	69.67	0.41
38	40.81	58.22	0.97
32.2	48.67	48.68	2.65
28.5	57.43	36.64	5.93
28.2	60.43	25.75	13.82

The isotherms for intervals of 10° lie so close together that they are practically indistinguishable for the greater part of their length.

#### SOLUBILITY OF NAPHTHALENE IN LIQUID CARBON DIOXIDE.

(Büchner, 1905-06.) (Synthetic Method used.)

Crit. Temp.	Gms. $C_{10}H_8$ per 100 Gms. Sat. Sol.
34.8	8
64	54
80	100

100 gms. 95% formic acid dissolve 0.30 gm. naphthalene at 18.5°. (Aschan, 1913.)  
100 gms. 95% formic acid dissolve 3.44 gms.  $\alpha$ -nitronaphthalene at 18.5°. "  
Data for equilibrium in the systems: naphthalene, phenol, water and naphthalene, succinic acid nitrile, water, determined by the synthetic method, are given by Timmermans (1907).

#### SOLUBILITY OF NAPHTHALENE IN:

t°.	Chloroform.	Carbon Tetra Chloride.	Carbon Di Sulphide.
	(Speyers; Etard.)	(Schröder — Z. physik. Ch. 11, 457, '93.)	(Arctowski — Compt. rend. 121, 123, '95; Etard.)
	Wt. of 1 cc. Solution.	Gms. $C_{10}H_8$ per 100 Grams $CHCl_3$ .	Gms. $C_{10}H_8$ per 100 Gms. Sat. Solution.
-108	...	...	0.62
-82	...	...	1.38
-50	...	...	2.3
-30	...	8.8	6.6
-10	...	15.6	14.1
0	1.393	19.5	19.9
+10	1.355	25.5	27.5
20	1.300	31.8	36.3
25	1.280	35.5	41.0
30	1.255	40.1	46.0
40	1.205	49.5	57.2
50	1.150	60.3	67.6
60	1.090	73.1	79.2
70	1.040	87.2	90.3

NOTE. — Speyers' results upon the solubility of  $C_{10}H_8$  in  $CHCl_3$ , when calculated to grams per 100 grams of solvent, agree quite well with Etard's (Ann. chim. phys. [7] 2 570, '94 figures, reported on the basis of grams  $C_{10}H_8$  per 100 grams saturated solution.



SOLUBILITY OF NAPHTHALENE IN:  
 (Schröder; Etard; Speyers.)

t°.	Benzene.	Chlor Benzene.	Hexane.	Toluene.	
	Gms. C <sub>10</sub> H <sub>8</sub> per 100 Gms. Solution.	Gms. C <sub>10</sub> H <sub>8</sub> per 100 Gms. Solution.	Gms. C <sub>10</sub> H <sub>8</sub> per 100 Gms. Solution.	Wt. of 1 cc. Solution.	Gms. per 100 C <sub>6</sub> H <sub>6</sub> .
-50	...	...	0.3	...	.
-20	...	...	1.9	...	.
0	...	...	5.5	0.9124	.
+10	27.5	24.0	9.0	0.9126	15
20	36.0	31.0	14.0	0.9135	28
25	40.5	35.0	17.5	0.9155	36
30	45.5	39.0	21.0	0.9180	42
40	54.0	48.0	30.8	0.9250	56
50	65.0	57.5	43.7	0.9350	69
60	77.5	70.5	60.6	0.9475	83
70	88.0	85.0	78.8	0.9640	97
80	...	...	...	0.9770	111

Freezing-point data (solubility, see footnote, p. 1) are given for mixtu naphthalene and each of the following compounds:

$\alpha$ Naphthol. (Crompton & Whitely, 1895; Küster, '95; Vignon, '91; Miers & Isaac, '08a.)	2.4 Dinitrophenol. { (Saposhniko Picric Acid. { Kremann, 1
$\beta$ Naphthol. (Crompton & Whitely, 1895; Vignon, 1891; Isaac, 1908.)	Pyridine. (Hatcher & Skirrow, 1
$\alpha$ Naphthylamine. (Vignon, 1891.)	Pyrocatechol. (Kremann & Janetsky
$\beta$ " "	Resorcinol. (Vignon, 1891; Kres Janetsky, 1912.)
Dihydronaphthalene. (Küster, 1891.)	Stearic Acid. (Courtonne, 18
Nitronaphthalene. (Palazzo & Battelli, 1883.)	Sulfur. (Bylert, )
Palmitic Acetic Ester. (Batelli & Martinetti, '85.)	Nitrotoluene. (Kremann, 190
Paraffin. (Palazzo & Battelli, 1883.)	1.2.4 Dinitrotoluene. "
Phenanthrene. (Vignon, 1891; Miolati, 1897.)	1.2.6 " (Kremann & Rodiai
Phenol. (Yamamoto, '08; Hatcher & Skirrow, '17.)	1.3.4 " "
<i>o</i> Nitrophenol. (Saposhnikow, '04; Kremann, '04.)	1.3.5 " "
<i>p</i> Nitrophenol. (Kremann, 1904.)	Trinitrotoluene. (Kremann, 190
	<i>p</i> Toluidine. (Vignon, 1891.)
	Thymol. (Rohoff, 1895.)

F.-pt. data are also given for the following mixtures:

Nitronaphthalene + Paraffin.	(Campetti & Delgrosso, 1913; Palazzo & Batelli
$\alpha$ Nitronaphthalene + Urethan.	(Mascarelli, 1908.)
$\alpha$ Nitronaphthalene + $\alpha$ Naphthylamine.	(Tsakalotos, 1912.)

 **$\beta$  NAPHTHALENE SULFONIC ACID** C<sub>10</sub>H<sub>7</sub>SO<sub>3</sub>H.

 SOLUBILITY IN AQUEOUS HYDROCHLORIC ACID AT 30°.
   
 (Masson, 1912.)

<i>d</i> <sub>20</sub> of Sat. Solution.	Mols. per Liter Sat. Sol.		Gms. per Liter Sat. Sol.	
	HCl.	C <sub>10</sub> H <sub>7</sub> SO <sub>3</sub> H.	HCl.	C <sub>10</sub> H <sub>7</sub> SO <sub>3</sub> H.
1.1925	0	3.263	0	679
1.1653	1.291	2.470	47.08	514
1.1553	1.826	2.117	66.59	440.6
1.1115	4.017	0.762	146.5	158.6
1.1197	7.232	0.089	263.7	18.5
1.1569	0.88	0.063	360.3	13.1



**$\beta$  NAPHTHOIC ACID  $C_{10}H_7COOH$ .**

One liter of aqueous solution contains 0.058 gm.  $C_{10}H_7COOH$  at 25°.

(Paul, 1894.)

**Dihydro  $\beta$  NAPHTHOIC ACIDS  $C_{10}H_7COOH$  (118° and 161° isomers).****SOLUBILITY OF EACH ISOMER, DETERMINED SEPARATELY, IN WATER.**

(Derick and Kamm, 1916.)

°.	cc. 0.01 N $Ba(OH)_2$ Solution Required per 10 cc. of the Sat. Solution of the:	
	118° Isomer.	161° Isomer.
0	0.39	0.19
20	0.56	0.34
40	1.34	0.69
55-56	2.89	1.45
71-72	6.7	3.48
80	9.3	4.68
90	14.6	8
96-97	20.1	10.5

 **$\beta$  NAPHTHOL  $C_{10}H_7OH$ .****SOLUBILITY IN WATER.**

°.	Gms. $\beta$ $C_{10}H_7OH$ per 100 cc. Sat. Sol.	Authority.
12.5	0.044	(Kuriloff, 1897.)
25.1	0.074	(Küster, 1895.)
29.5	0.0876	(Kuriloff, 1898.)

Data for the solubility of isomorphous mixtures of  $\beta$  naphthol and naphthalene in water at 25.1° are given by Küster (1895).

**SOLUBILITY OF  $\beta$  NAPHTHOL IN AQUEOUS SOLUTIONS OF PICRIC ACID AT 29°.**

(Kuriloff, 1898.)

Mole. X 100 per 100 cc. Solution.		Gms. per 100 cc. Solution.		Solid Phase.
$C_6H_3OH(NO_2)_3$	$C_{10}H_7OH$	$C_6H_3OH(NO_2)_3$	$C_{10}H_7OH$	
0	609	0	0.0877	$\beta$ Naphthol
54	615	0.0124	0.0886	"
68	620	0.0157	0.0894	" + $\beta$ Naphtholpicrate
69	607	0.0158	0.0875	$\beta$ Naphtholpicrate
69	597	0.0158	0.0860	"
88	494	0.0212	0.0712	"
100	390	0.0229	0.0562	"
106	180	0.0449	0.0259	"
308	105	0.0706	0.0151	"
933	8	0.2138	0.0011	" + Picric Acid
928	0	0.2126	0	Picric Acid

Data are also given for the distribution of  $\beta$  naphthol between water and benzene. The mean of the conc. in  $C_6H_6$  layer divided by conc. in  $H_2O$  layer is given as 67. The temperature is not given. The determination of the  $\beta$  naphthol was made by an iodine titration method.

The coefficient of distribution of  $\beta$  naphthol between  $H_2O$  and  $CHCl_3$  at 25° is; conc.  $H_2O$  + conc. in  $CHCl_3$  = 0.0171. (Marden, 1914.)

Data for the solubility of  $\beta$  naphthol, picric acid (naphthol picrate) and their mixtures in benzene, determined by the synthetic (sealed tube) method, are given by Kuriloff (1897a).

100 cc. 90% alcohol dissolve about 55 gms.  $\beta$   $C_{10}H_7OH$  at 15.5°.

(Greenish and Smith, 1903.)

100 gms. 95% formic acid dissolve 3.11 gms.  $\beta$   $C_{10}H_7OH$  at 18.6°. (Aschaa, 1913.)



SOLIDIFICATION TEMPERATURES OF MIXTURES OF  $\beta$  NAPHTHOL AND SAL  
(Bellucci, 1912.)

t° of Solidification.	Gms. $\beta$ C <sub>10</sub> H <sub>7</sub> OH per 100 Gms. Mixture.	t° of Solidification.	Gms. $\beta$ C <sub>10</sub> H <sub>7</sub> OH p 100 Gms. Mixture.
121.7	100	80	40
116.5	90	68	30
111	80	52.5	20
105	70	34 Eutec.	10
97.5	60	38.5	5
88	50	42	0

FREEZING-POINT DATA (Solubility, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES:

$\alpha$ Naphthol	+ $\alpha$ Naphthylamine.	(Vignon, 1891.)
"	+ $\beta$	"
"	+ Dimethylpyrone.	(Kendall, 1914.)
"	+ Resorcinol.	(Vignon, 1891.)
"	+ <i>p</i> Toluidine.	(Vignon, 1891; Philip, 1903.)
$\beta$ Naphthol	+ $\alpha$ Naphthol.	(Vignon, 1891; Crompton and Whiteley,
"	+ $\alpha$ Naphthylamine	(Vignon, 1891.)
"	+ $\beta$	"
"	+ Dimethylpyrone	(Kendall, 1914.)
"	+ Picric Acid.	(Kendall, 1916.)
"	+ Sulfonal	(Bianchini, 1914.)
"	+ <i>p</i> Toluidine.	(Vignon, 1891.)

$\alpha$  NAPHTHYLAMINE *p* Sulfonic Acid, 1.4  $\alpha$  C<sub>10</sub>H<sub>7</sub>NH<sub>2</sub>.SO<sub>3</sub>H.

$\alpha$  NAPHTHYLAMINE *o* Sulfonic Acid, 1.2  $\alpha$  C<sub>10</sub>H<sub>7</sub>NH<sub>2</sub>.SO<sub>3</sub>H.

SOLUBILITY OF EACH SEPARATELY IN WATER.  
(Dolinski, 1905.)

t°.	Gms. per 100 Gms. H <sub>2</sub> O.		t°.	Gms. per 100 Gms. H <sub>2</sub> O.	
	<i>p</i> Sulphonic Ac.	<i>o</i> Sulphonic Ac.		<i>p</i> Sulphonic Ac.	<i>o</i> Sulphonic Ac.
0	0.027	0.24	50	0.059	0.81
10	0.029	0.32	60	0.075	1.01
20	0.031	0.41	70	0.097	1.37
30	0.037	0.52	80	0.130	1.80
40	0.048	0.65	90	0.175	2.40
			100	0.228	3.19

The coefficient of distribution of  $\beta$  naphthylamine between benzene and at 25° is; conc. in C<sub>6</sub>H<sub>6</sub> ÷ conc. in H<sub>2</sub>O = 279. The coefficient for  $\alpha$  naphthylamine, similarly determined, is 252.

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## FREEZING-POINT DATA ARE GIVEN FOR THE FOLLOWING MIXTURE

$\alpha$ Naphthylamine	+ Phenol.	(Philip, 1903.)
"	+ Quinol.	(Philip & Smith, 1905.)
"	+ Resorcinol.	( " ; Vignon, 1891.)
"	+ <i>p</i> Toluidine.	(Vignon, 1891.)
$\beta$ Naphthylamine	+ Phenol.	(Kreman, 1906.)
"	+ Resorcinol.	(Vignon, 1891.)
"	+ <i>p</i> Toluidine.	"

$\beta$  NAPHTHYL BENZOATE C<sub>6</sub>H<sub>5</sub>COOC<sub>10</sub>H<sub>7</sub>.

100 gms. 95% formic acid dissolve 0.25 gm. C<sub>6</sub>H<sub>5</sub>COOC<sub>10</sub>H<sub>7</sub> at 18.6°.

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NARCEINE C<sub>23</sub>H<sub>27</sub>NO<sub>8</sub> + 3H<sub>2</sub>O.

100 gms. H<sub>2</sub>O dissolve 0.078 gm. narceine at 13°; 100 gms. 80% alcohol 0.105 gm. at 13°.

100 gms. CCl<sub>4</sub> dissolve 0.011 gm. narceine at 17° (Schindelmeyer, 1901) gm. at 20° (Gori, 1913).



**NARCOTINE**  $C_{20}H_{28}NO_7$ .**SOLUBILITY IN SEVERAL SOLVENTS.**

Solvent.	g°.	Gms. Narcotine per 100 Gms. Solvent.	Authority.
Water	15	0.1*	(Guerin, 1913.)
Water	20	0.00445	(Zalai, 1910.)
Acetone	15	41.96*	(Guerin, 1913.)
Aq. 50 Vol. % Acetone	15	0.7*	"
Aniline	20	25	(Scholtz, 1912.)
Pyridine	20	2.3	"
Piperidine	20	1.7	"
Diethylamine	20	0.4	"
Carbon Tetrachloride	20	1.04	(Gori, 1913.)
Trichlor Ethylene	15	6.5	(Wester and Bruins, 1914.)
Oil of Sesame	20	0.086	(Zalai, 1910.)

\* Per 100 cc. solvent.

**NEODYMIUM CHLORIDE**  $NdCl_3 \cdot 6H_2O$ .**SOLUBILITY IN WATER.** (Matignon, 1906, 1909.)

Method of obtaining saturation not stated.

g°.	$d_{15}^4$ of Sat. Sol.	Gms. $NdCl_3$ per 100 Gms.		Gms. $NdCl_3 \cdot 6H_2O$ per 100 Gms.	
		Sat. Sol.	Water.	Sat. Sol.	Water.
13	1.74	49.67	98.68	71.12	246.2
100	...	...	140	...	...

100 gms. abs. alcohol dissolve 44.5 gms. (anhydrous)  $NdCl_3$  at 20°. Saturation as obtained by spontaneous evaporation of the solution over  $H_2SO_4$ .

(Matignon, 1906.)

100 gms. anhydrous pyridine dissolve 1.8 gms. anhydrous  $NdCl_3$  at about 15°. Saturation obtained by daily agitation of the solution for some weeks. (Matignon, '06.)**NEODYMIUM COBALTICYANIDE**  $Nd_2(CoC_6N_6)_2 \cdot 9H_2O$ .1000 gms. aq. 10%  $HCl$  ( $d_{18} = 1.05$ ) dissolve 4.19 gms. salt at 25°. (James & Willand, '16.)**NEODYMIUM GLYCOLATE**  $Nd(C_2H_3O_2)_3$ .One liter  $H_2O$  dissolves 4.609 gms. salt at 20°.

(Jantsch &amp; Grünkraut, 1912-13.)

**NEODYMIUM MOLYBDATE**  $Nd_2(MoO_4)_3$ .One liter  $H_2O$  dissolves 0.0186 gm. salt at 28° and 0.0308 gm. at 75°. The mixtures were frequently stirred at constant temperature during only two hours. (Hitchcock, 1895.)**NEODYMIUM Double NITRATES.****SOLUBILITY IN Aq.  $HNO_3$  OF  $d_{15}^4 = 1.325$  (= 51.59 GMS.  $HNO_3$  PER 100 CC.) AT 16°.** (Jantsch, 1912.)

Double Salt.	Formula.	Gms. Hydrated Double Salt per 100 Gms. Sat. Sol.
Neodymium Magnesium Nitrate	$[Nd(NO_3)_6]_2Mg_3 \cdot 24H_2O$	97.7
" Nickel	" $Ni_3$ "	116.6
" Cobalt	" $Co_3$ "	151.6
" Zinc	" $Zn_3$ "	177
" Manganese	" $Mn_3$ "	296

**NEODYMIUM OXALATE**  $Nd_2(C_2O_4)_3 \cdot 10H_2O$ .**SOLUBILITY IN WATER AT 25° BY ELECTROLYTIC DETERMINATION.** (Rimbach and Schubert, 1909.)

One liter sat. solution contains 0.0053 mg. equivalents of anhydrous salt = 0.49 gram.

**SOLUBILITY IN AQUEOUS 20% SOLUTIONS OF METHYL, ETHYL AND TRIETHYL AMINE OXALATES, ROUGHLY DETERMINED.** (Grant and James, 1917.)

c. aq. 20% methyl amine oxalate dissolve 0.027 gm. neodymium oxalate.					
" ethyl "	"	"	"	0.107	"
" triethyl "	"	"	"	0.065	"



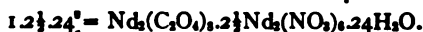
# NEODYMIUM OXALATE

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## SOLUBILITY OF NEODYMIUM OXALATE IN AQUEOUS SOLUTIONS OF NEODYMIUM NITRATE AT 25°. (James and Robinson, 1913.)

(The mixtures were constantly agitated at constant temperature for twelve weeks.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{Nd}_2(\text{C}_2\text{O}_4)_3$	$\text{Nd}_2(\text{NO}_3)_6$		$\text{Nd}_2(\text{C}_2\text{O}_4)_3$	$\text{Nd}_2(\text{NO}_3)_6$	
0.18	6.46	$\text{Nd}_2(\text{C}_2\text{O}_4)_3 \cdot 11\text{H}_2\text{O}$	2.07	47.64	$\text{Nd}_2(\text{C}_2\text{O}_4)_3 \cdot 11\text{H}_2\text{O}$
0.54	12.23	"	2.54	50.52	"
0.76	17.78	"	2.89	52.82	"
0.85	22.67	"	3.17	54.67	"
0.96	27.43	"	2.21	56.48 probably	$1.24$
1.28	31.36	"	1.44	59.68	$\text{Nd}_2(\text{NO}_3)_6 \cdot 7\text{H}_2\text{O}$
1.38	35.26	"	1.33	59.67	"
1.66	38.70	"	1.21	59.70	"
1.88	42.13	"	0.96	59.75	"
1.96	44.82	"	...	60.46	"



## NEODYMIUM Dimethyl PHOSPHATE $\text{Nd}_2[(\text{CH}_3)_2\text{PO}_3]_6$

100 gms.  $\text{H}_2\text{O}$  dissolve 56.1 gms.  $\text{Nd}_2[(\text{CH}_3)_2\text{PO}_3]_6$  at 25° and about 22.3 gms. at 95°. (Morgan and James, 1914)

## NEODYMIUM SULFATE $\text{Nd}_2(\text{SO}_4)_3$

### SOLUBILITY IN WATER. (Muthmann and Rolig, 1898.)

t°.	Gms. $\text{Nd}_2(\text{SO}_4)_3$ per 100 Gms.		t°.	Gms. $\text{Nd}_2(\text{SO}_4)_3$ per 100 Gms.	
	Solution.	Water.		Solution.	Water.
0	8.7	9.5	50	3.5	3.7
16	6.6	7.1	80	2.6	2.7
30	4.7	5	108	2.2	2.3

## NEODYMIUM SULFONATES.

### SOLUBILITY IN WATER.

Sulfonate.	Formula.	t°.	Gms. Anhydrous Salt per 100 Gms. $\text{H}_2\text{O}$ .	Authority.
Neodymium:				
m	Nitrobenzene $\text{Nd}[\text{C}_6\text{H}_4(\text{NO}_2)\text{SO}_3]_3 \cdot 6\text{H}_2\text{O}$	15	46.1	(Holmberg, 1907)
Bromo	Sulfonate $\text{Nd}[\text{C}_6\text{H}_3\text{Br}(\text{I})\text{NO}_2(\text{4})\text{SO}_3(\text{3})]_3 \cdot 8\text{H}_2\text{O}$	25	7.25	(Katz & James, 1914)

## NEODYMIUM TUNGSTATE $\text{Nd}_2(\text{WO}_4)_3$

One liter  $\text{H}_2\text{O}$  dissolves 0.0190 gm.  $\text{Nd}_2(\text{WO}_4)_3$  at 22°, 0.0168 gm. at 65° 0.0152 gm. at 98°. The mixtures were not constantly agitated and only hours were allowed for saturation. (Hitchcock, 1877)

## NEON Ne.

### SOLUBILITY IN WATER. (v. Antropoff, 1909-10.)

t°.	0.	10.	20.	30.	40.	50.
Coef. of Absorption $\beta$	0.0114	0.0118	0.0147	0.0158	0.0203	0.0311

The results are in terms of the coefficient of absorption as defined by Bunson (see p. 227) and modified by Kuenen, in respect to substitution of mass of  $\text{H}_2\text{O}$  for volume of  $\text{H}_2\text{O}$  in the formula Absorp. coef. Kuenen =  $\frac{(w - v) 760}{\text{mass of } \text{H}_2\text{O} \times P}$

## NEURINE PERCHLORATE $\text{CH}_3\text{CH.N}(\text{CH}_3)_2\text{OH.HClO}_4$

100 gms.  $\text{H}_2\text{O}$  dissolve 2.5 gms. of the salt at 14.5°. (Hofmann & Hübner, 1911)



**NEL BROMATE**  $\text{Ni}(\text{BrO}_3)_2 \cdot 6\text{H}_2\text{O}$ .

gms. cold water dissolve 27.6 gms. nickel bromate.

**NEL BROMIDE**  $\text{NiBr}_2 \cdot 6\text{H}_2\text{O}$ .

SOLUBILITY IN WATER.  
(Etard, 1894.)

t°.	Gms. $\text{NiBr}_2$ per 100 Gms. Solution.	t°.	Gms. $\text{NiBr}_2$ per 100 Gms. Solution.	t°.	Gms. $\text{NiBr}_2$ per 100 Gms. Solution.
-20	47.7	25	57.3	80	60.6
-10	50.5	30	58	100	60.8
0	53	40	59.1	120	60.9
+10	55	50	60	140	61
20	56.7	60	60.4		

**NEL CARBONATE**  $\text{NiCO}_3$ .

liter  $\text{H}_2\text{O}$  dissolves  $7.789 \times 10^{-4}$  mols.  $\text{NiCO}_3 = 0.0925$  gm. at  $25^\circ$ .  
(Ageno and Valla, 1911.)

**NEL CARBOXYL.**

gms. of the aqueous solution saturated at  $9.8^\circ$  contain 2.36 cc. of the vapor  
3 milligrams Ni. In blood serum it is  $2\frac{1}{2}$  times as soluble. (Armit, 1907.)

**NEL CHLORATE**  $\text{Ni}(\text{ClO}_3)_2$ .

SOLUBILITY IN WATER.  
(Meusser — Ber. 35, 1419, '02.)

Gms. $\text{Ni}(\text{ClO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Ni}(\text{ClO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Ni}(\text{ClO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Ni}(\text{ClO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
49.55	7.84	$\text{Ni}(\text{ClO}_3)_2 \cdot 6\text{H}_2\text{O}$	48	67.60	16.65	$\text{Ni}(\text{ClO}_3)_2 \cdot 4\text{H}_2\text{O}$
51.52	8.49	"	55	68.78	17.59	"
52.66	8.88	"	65	69.05	18.01	"
56.74	10.47	"	79.5	75.50	24.68	"
64.47	15.35	"	-13.5	31.85	3.73	Ice
			-9	26.62	2.90	"

Gr. of solution saturated at  $+18 = 1.661$ .

ording to Carlson (1910) 100 gms. sat. sol. in  $\text{H}_2\text{O}$  at  $16^\circ$  contain 64.1 gms.  
 $\text{O}_2$  and  $d_{20}$  of sat. sol. = 1.76.

**NEL PerCHLORATE**  $\text{Ni}(\text{ClO}_4)_2 \cdot 9\text{H}_2\text{O}$ .

SOLUBILITY IN WATER.  
(Goldblum and Terlikowski, 1912.)

d of Sat. Sol.	Gms. $\text{Ni}(\text{ClO}_4)_2$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	d of Sat. Sol.	Gms. $\text{Ni}(\text{ClO}_4)_2$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
...	0	Ice	-21.3	...	92.5	$\text{Ni}(\text{ClO}_4)_2 \cdot 9\text{H}_2\text{O}$
.9	33.19	"	0	1.573	104.6	$\text{Ni}(\text{ClO}_4)_2 \cdot 5\text{H}_2\text{O}$
.3	46.68	"	7.5	1.576	106.8	$\text{Ni}(\text{ClO}_4)_2 \cdot 5\text{H}_2\text{O}$
.7	70	"	18	1.576	110.1	"
...	...	Ice + $\text{Ni}(\text{ClO}_4)_2 \cdot 9\text{H}_2\text{O}$	26	1.584	112.2	"
.7	90	$\text{Ni}(\text{ClO}_4)_2 \cdot 9\text{H}_2\text{O}$	45	1.594	118.6	"



**NICKEL CHLORIDE**

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**NICKEL CHLORIDE**  $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$ .**SOLUBILITY IN WATER.**

(Etard, 1894.)

t°.	Gms. $\text{NiCl}_2$ per 100 Gms. Solution.	t°.	Gms. $\text{NiCl}_2$ per 100 Gms. Solution.	t°.	Gms. $\text{NiCl}_2$ per 100 G. a. Solution.
-17	29.7	25	40	60	45.1
0	35	30	40.8	70	46
+10	37.3	40	42.3	78	46.6
20	39.1	50	43.9	100	46.7

1000 cc. sat. HCl solution dissolve 4 gms.  $\text{NiCl}_2$  at 12°.

(Ditte, 1861.)

100 gms. abs. alcohol dissolve 10.05 gms.  $\text{NiCl}_2$  at room temperature.100 gms. abs. alcohol dissolve 53.71 gms.  $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$  at room temperature.

(Böttcher, 1897.)

100 gms. abs. alcohol dissolve 2.16 gms.  $\text{NiCl}_2 \cdot 7\text{H}_2\text{O}$  at 17°, and 1.4 gms. at 3°.

(de Bruyn, 1892.)

100 gms. saturated solution in glycol contain 16.2 gms.  $\text{NiCl}_2$  at room temperature.

(de Coninck, 1905.)

100 cc. anhydrous hydrazine dissolve 8 gms.  $\text{NiCl}_2$  at room temp. and solution is colored violet.

(Welsh and Broderman, 1915.)

100 gms. 95% formic acid dissolve 5.9 gms.  $\text{NiCl}_2$  at 20.5°.

(Aschan, 1913.)

When 1 gm. of nickel, as chloride, is dissolved in 100 cc. of 10% aq. HCl and shaken with 100 cc. of ether, 0.01 per cent of the Nickel enters the ethereal layer

(Mylius, 1911.)

**NICKEL CITRATE**  $\text{Ni}_3[(\text{COOCH}_3)_2\text{C}(\text{OH})\text{COO}]_3 \cdot 2\text{H}_2\text{O}$ .

100 cc. sat. solution in water contain 0.28 gm. Ni = 0.94 gm. anhydrous salt at 10°.

(Pickering, 1915)

**NICKEL Potassium CITRATE**  $\text{K}_4\text{Ni}[(\text{COOCH}_3)_2\text{COHCOO}]_3$ .

100 cc. sat. sol. in water contain 3.9 gms. Ni = 41 gms. salt at 10°.

(Pickering, 1915)

**NICKEL HYDROXIDE**  $\text{Ni}(\text{OH})_2$ .

Aqueous ammonia solutions of nickel hydroxide were evaporated in a vacuum desiccator and samples withdrawn at intervals for analysis. The results obtained in duplicate series yielded different curves. For 2  $n$   $\text{NH}_3$ , the gms. Ni per liter varied from 0.17 to 0.83. For 4  $n$   $\text{NH}_3$ , the gms. Ni per liter varied from 0.1 to 1.8.

(Bonsdorff, 1896)

**NICKEL IODATE**  $\text{Ni}(\text{IO}_3)_2$ .**SOLUBILITY IN WATER.**

(Meusser — Ber. 34, 2440, '01.)

t°.	Gms. $\text{Ni}(\text{IO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Ni}(\text{IO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Ni}(\text{IO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Ni}(\text{IO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
0	0.73	0.033	$\text{Ni}(\text{IO}_3)_2 \cdot 4\text{H}_2\text{O}$	18	0.55	0.0245	$\text{Ni}(\text{IO}_3)_2 \cdot 2\text{H}_2\text{O}$
18	1.01	0.045	"	50	0.81	0.035	"
30	1.41	0.063	"	75	1.03	0.045	"
0	0.53	0.023	$\text{Ni}(\text{IO}_3)_2 \cdot 2\text{H}_2\text{O}$ (1)	80	1.12	0.049	"
18	0.68	0.030	"	30	1.135	0.050	$\text{Ni}(\text{IO}_3)_2$
30	0.86	0.039	"	50	1.07	0.046	"
50	1.78	0.080	"	75	1.02	0.045	"
8	0.52	0.023	$\text{Ni}(\text{IO}_3)_2 \cdot 2\text{H}_2\text{O}$ (2)	90	0.988	0.044	"

(1)  $\alpha$  Dihydrate.(2)  $\beta$  Dihydrate.



**IODIDE**  $\text{NiI}_2 \cdot 6\text{H}_2\text{O}$ .

SOLUBILITY IN WATER. (Etard, 1894.)

Gms. $\text{NiI}_2$ per 100 Gms. Solution	t°.	Gms. $\text{NiI}_2$ per 100 Gms. Solution.	t°.	Gms. $\text{NiI}_2$ per 100 Gms. Solution.
52	25	60.7	60	64.8
55.4	30	61.7	70	65
57.5	40	63.5	80	65.2
59.7	50	64.7	90	65.3

olution the tr. pt. for  $\text{NiI}_2 \cdot 6\text{H}_2\text{O} + \text{NiI}_2 \cdot 4\text{H}_2\text{O}$  is at  $43^\circ$ .**MALATE**  $\text{Ni}[\text{CH}_2\text{CHOH}(\text{COO})]_2 \cdot 3\text{H}_2\text{O}$ .a. solution in water contain 0.02 gm. Ni = 0.06 gm. salt at  $10^\circ$ .  
(Pickering, 1915.)**NITRATE**  $\text{Ni}(\text{NO}_3)_2$ .

SOLUBILITY IN WATER.

(Funk — Wiss. Abh. p. 1. Reichenstalt, 3, 439, '00.)

n. O <sub>2</sub> tion.	Mols. $\text{Ni}(\text{NO}_3)_2$ Gms. per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Ni}(\text{NO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Ni}(\text{NO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
.02	6.31	$\text{Ni}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	20	49.06	9.49	$\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
.48	6.43	"	41	55.22	12.1	"
.13	7.79	"	56.7	62.76	16.7	"
.94	6.55	$\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	58	61.61	15.9	$\text{Ni}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$
.59	7.01	"	60	61.99	16.0	"
.11	7.16	"	64	62.76	16.6	"
.00	7.44	"	70	63.95	17.6	"
.32	7.86	"	90	70.16	23.1	"
.59	9.3	"	95	77.12	33.3	"

sat. solution in glycol contain 7.5 gms.  $\text{Ni}(\text{NO}_3)_2$  at room temperature.  
(de Coninck.)hydrous hydrazine dissolve 3 gms.  $\text{Ni}(\text{NO}_3)_2$  at room temp.  
(Welsh and Brodermon, 1915.)**OXALATE**  $\text{Ni}(\text{COO})_2$ .95% formic acid dissolve 0.01 gm. at  $19.8^\circ$ . (Aschan, 1913.)**SULFATE**  $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$ .

SOLUBILITY IN WATER. (Steele and Johnson, 1904; see also Tobler, Etard and Mulder.)

Gms. $\text{NiSO}_4$ per 100 Gms. Solution.	Gms. $\text{NiSO}_4$ per 100 Gms. Water.	Solid Phase.	t°.	Grams $\text{NiSO}_4$ per 100 Gms.		Solid Phase.
				Solution.	Water.	
0.47	25.74	$\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$	33.0	30.25	43.35	$\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$
1.40	27.22	"	35.6	30.45	43.79	" (blue)
3.99	31.55	"	44.7	32.45	48.05	"
7.48	37.90	"	50.0	33.39	50.15	"
9.99	42.46	"	53.0	34.38	52.34	"
0.57	44.02	"	54.5	34.43	52.50	$\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$
1.38	45.74	"	57.0	34.81	53.40	" (green)
1.20	45.5	"	60	35.43	54.80	"
0.35	43.57	$\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$	70	37.29	59.44	"
0.25	43.35	" (blue)	80	38.71	63.17	"
0.49	43.83	"	99	43.42	76.71	"

1 points, hepta hydrate  $\rightleftharpoons$  hexa hydrate =  $31.5^\circ$ .  
rate (blue)  $\rightleftharpoons$  hexa hydrate (green) =  $53.3^\circ$ .



## SOLUBILITY OF MIXTURES OF NICKEL SULPHATE AND COPPER

(Fock — Z. Kryst. Min. 28, 387, '97.)

## Results at 35°.

Gms. per 100 Gms. H <sub>2</sub> O.		Mol. per cent in Solution.		Mol. per cent in Solid Phase.	
CuSO <sub>4</sub> .	NiSO <sub>4</sub> .	CuSO <sub>4</sub> .	NiSO <sub>4</sub> .	CuSO <sub>4</sub> .	NiSO <sub>4</sub> .
9.62	583.9	1.57	98.43	0.35	99.65
41.66	484.4	7.69	92.31	2.12	97.88
75.39	553.5	11.66	88.34	4.77	95.23
106.40	506.5	16.92	83.08	6.52	93.48
172.0	483.8	25.63	74.37	13.88	86.17
186.9	468.0	27.90	72.10	18.77	81.23
				94.91	5.09

## Results at 67°.

20.04	729.3	2.65	97.35	0.93	99.07
66.01	706.2	8.31	91.69	2.86	97.14
88.08	501.6	13.55	86.45	3.92	96.08
47.94	675.0	16.39	83.61	6.66	93.34
249.9	747.8	24.46	75.54	22.32	77.68

## SOLUBILITY OF MIXTURES OF NICKEL SULPHATE AND SODIUM SULPHATE, ETC.

(Koppel; Wetzel — Z. physik. Chem. 52, 401, '05.)

t°.	Gms. per 100 Gms. Solution.		Gms. per 100 Gms. H <sub>2</sub> O.		Mols. per 100 Mols. H <sub>2</sub> O.		
	NiSO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	NiSO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	NiSO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	
0	16.94	7.61	22.46	10.09	2.61	1.28	Ni
5	17.99	10.85	25.28	15.24	2.94	1.93	
10	18.97	13.85	28.26	20.64	3.29	2.61	
20	18.76	17.21	29.31	26.87	3.410	3.404	
25	17.85	16.54	27.33	25.33	3.181	3.208	
30	16.74	15.34	24.64	22.58	2.868	2.861	Ni
35	16.28	14.91	23.66	21.67	2.753	2.744	
40	15.35	14.49	21.88	20.65	2.546	2.616	
18.5	19.61	16.49	30.70	25.80	3.56	3.27	
20	20.13	16.15	31.59	25.35	3.67	3.21	Ni
25	21.20	14.77	33.11	23.06	3.85	2.92	
30	22.60	12.80	34.98	19.82	4.07	2.59	
35	23.62	10.78	36.01	16.43	4.19	2.08	
40	24.92	9.39	37.93	14.29	4.41	1.81	
18.5	16.80	18.93	26.14	29.45	3.04	3.72	Ni
20	15.48	20.18	24.06	31.37	2.80	3.97	
25	10.92	24.12	16.81	37.13	1.96	4.70	
30	6.40	28.71	9.87	44.25	1.15	5.60	
35	4.54	31.65	7.13	49.59	0.838	6.28	
40	4.63	31.37	7.24	49.03	0.843	6.21	Ni



**SOLUBILITY OF NICKEL POTASSIUM SULFATE  $\text{NiK}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$  IN WATER.**  
(Tobler, 1855; v. Hauer, 1858.)

t°.	Gms. $\text{NiK}_2(\text{SO}_4)_2$ per 100 Gms. $\text{H}_2\text{O}$ .		t°.	Gms. $\text{NiK}_2(\text{SO}_4)_2$ per 100 Gms. $\text{H}_2\text{O}$ .	
	(Tobler.)	(v. Hauer.)		(Tobler.)	(v. Hauer.)
0	5.3	...	50	30	...
10	8.9	...	60	35.4	20.47
20	13.8	9.53	70	42	...
30	18.6	...	80	46	28.2
40	24	14.03			

**SOLUBILITY OF NICKEL SULFATE IN AQUEOUS SOLUTIONS OF METHYL ALCOHOL AT 14°.**  
(de Bruyn, 1903.)

Small test tubes of 4-6 cc. capacity, were used. They were almost completely filled with the salt and solvent and placed in the bath in an inclined position with salt occupying the upper part of the tube. This caused a "spontaneous circulation of the solvent." The solutions were analyzed by precipitating  $\text{NiO}$  with  $\text{KOH}$  at the boiling point, in porcelain vessels.

Wt. Per cent $\text{CH}_3\text{OH}$ in Solvent.	Gms. $\text{NiSO}_4$ per 100 Gms. Sat. Sol. in Contact with:			
	$\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$ as Solid Phase.	$\text{NiSO}_4 \cdot 6\text{H}_2\text{O} \alpha$ as Solid Phase.	$\text{NiSO}_4 \cdot 6\text{H}_2\text{O} \beta$ as Solid Phase.	$\text{NiSO}_4 \cdot 4\text{H}_2\text{O}$ as Solid Phase.
0 ( $\text{H}_2\text{O}$ )	26.4	26 (low)	27.2	25.1
10	19.7	22 (?)	20.4	...
20	13.1	14.7	14	14.8
30	6.8	6.6	7.5	...
40	2.8	2.4	3.1	...
50	1.3	1	1.4	1.4
60	0.8	0.4	0.6	...
70	0.6	0.2	0.4	...
80	0.65	0.2	0.4	0.66
85	1.5	0.3	0.7	...
90	5.7	1.2	2.5	...
95	11	6	9 (?)	...
100	16.8	12.4 (low)	15.7 (low)	7.38

$\text{NiSO}_4 \cdot 6\text{H}_2\text{O} \alpha$  is greenish blue.  $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$  is more greenish than the  $\alpha$  salt.

**SOLUBILITY OF  $\text{NiSO}_4 \cdot 3\text{CH}_3\text{OH} \cdot 3\text{H}_2\text{O}$  IN AQUEOUS  $\text{CH}_3\text{OH}$  AT 14°.**  
(de Bruyn, 1903.)

Wt. Per cent $\text{CH}_3\text{OH}$ .	Gms. $\text{NiSO}_4$ per 100 Gms. Sat. Sol.	Wt. Per cent $\text{CH}_3\text{OH}$ .	Gms. $\text{NiSO}_4$ per 100 Gms. Sat. Sol.
85	1.93	90	0.70
86	1.73	92.5	0.50
87	1.48	95	0.455
88	1.25	97.5	0.77
89	1.01	100	3.72

Approximately two hours were allowed for attainment of equilibrium.

In solutions containing more than 15%  $\text{H}_2\text{O}$  the salt is gradually transformed to  $\text{NiSO}_4 \cdot 6\text{H}_2\text{O} \beta$ .

100 gms. absolute ethyl alcohol dissolve 1.4 gm.  $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$  at 4° and 2.2 gm. at 17°. (de Bruyn, 1892.)

100 gms. sat. solution in glycol contain 9.7 gms.  $\text{NiSO}_4$  at room temp. (de Coninck, 1905.)

**NICKEL SULFIDE  $\text{NiS}$ .**

One liter  $\text{H}_2\text{O}$  dissolves  $39.9 \times 10^{-4}$  gm. mols.  $\text{NiS} = 0.0036$  gm. at 18°, by conductivity method. (Weigel, 1906.)

Fusion-point data for  $\text{Ni}_2\text{S} + \text{Na}_2\text{S}$  and  $\text{Ni}_3\text{S}_2 + \text{Na}_2\text{S}$  are given by Friedrich (1914).



# NICOTINE

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## NICOTINE $C_{10}H_{14}N_2$ .

### SOLUBILITY IN WATER.

(Hudson, 1904.)

Determinations made by Synthetic Method, for which see Note, page Below 60° and above 210° both liquids are miscible in all proportions; like with percentages of nicotine less than 6.8 and above 82 per cent the liquid not show two layers at any temperature. Below 94° the upper layer is wa Above 94° the upper layer is nicotine. The curve plotted from the follow results makes a complete circle.

Percentage of Nicotine in the Mixture.	Temperature of Appearance of Two Layers. Degrees C.	Temperature of Homogeneity. Degrees C.
6.8	94	95
7.8	89	155
10.0	75	...
14.8	65	200
32.2	61	210
49.0	64	205
66.8	72	190
80.2	87	170
82.0	129	130

Additional data for the above system are given by Tsakalotos (1909). values for the temperatures of saturation are in general, from 1° to 5° lower t those of Hudson.

## NIOBIUM Potassium FLUORIDE $NbK_3F_7$ .

### SOLUBILITY IN WATER AND IN AQUEOUS HF AND AQUEOUS KF SOLUTION (Ruff and Schiller, 1911.)

The determinations were made in platinum vessels. The mixtures w shaken for 3 hour periods at constant temperature and the saturated soluti filtered through platinum funnels.

Solvent.	t°.	Gms. per 100 Gms. Sat. Solution.			Solid Phase.
		NbF <sub>5</sub> .	KF.	HF.	
Water	16	5.19	2.98	0.35	$K_2NbOF_5 \cdot H_2O$
"	16	7.07	5.33	4.35	$K_2NbOF_5 \cdot H_2O + K_2Nb$
Aq. 10.95% HF	16	4.33	2.32	10.43	$K_2NbF_7$
" 7.41% KF	16	1.16	5.54	0.13	$K_2NbOF_5 \cdot H_2O$
" 7.39% LF	16	2.67	6.04	5.39	$K_2NbOF_5 \cdot H_2O + K_2NM$
Water	85	30.39	14.68	0.35	$K_2NbOF_5 \cdot H_2O(?)$
Aq. 4.81% KF	80	11.66	10.08	1.53	"

## NITRIC ACID $HNO_3$ .

### DISTRIBUTION OF NITRIC ACID BETWEEN WATER AND ETHER AT 25° (Bogdan, 1905, 1906.)

Mols. $HNO_3$ per Liter of:		Mols. $HNO_3$ per Liter of:	
H <sub>2</sub> O Layer.	Ether Layer.	H <sub>2</sub> O Layer.	Ether Layer.
0.9145	0.0855	0.09005	0.00181
0.4811	0.0278	0.04749	0.00064
0.2644	0.00894	0.02760	0.00029
0.1392	0.00278	0.02462	0.00025



**RECIPROCAL SOLUBILITY OF NITRIC ACID AND WATER, DETERMINED BY THE  
FREEZING-POINT METHOD.**

(Küster and Kremann, 1904; see also Pickering, 1893.)

t°.	Gms. HNO <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. HNO <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-10	13.9	Ice	-40	69.7	HNO <sub>3</sub> ·3H <sub>2</sub> O
-20	22.9	"	-42 Eutec.	70.5	" + HNO <sub>3</sub> ·H <sub>2</sub> O
-30	27.8	"	-40	72.5	HNO <sub>3</sub> ·H <sub>2</sub> O
-40	31.5	"	-38 m. pt.	77.75	"
-43 Eutec.	32.7	" + HNO <sub>3</sub> ·3H <sub>2</sub> O	-40	82.4	"
-40	34.1	HNO <sub>3</sub> ·3H <sub>2</sub> O	-50	86.5	"
-30	40	"	-60	88.8	"
-20	49.2	"	-66.3 Eutec.	89.95	" + HNO <sub>3</sub>
-18.5 m. pt.	53.8	"	-60	91.9	HNO <sub>3</sub>
-20	58.5	"	-50	94.8	"
-30	65.4	"	-41.2 m. pt.	100	"

**NITROGEN N<sub>2</sub>**

**SOLUBILITY IN WATER.**

(Winkler — Ber. 24, 3606, '91; Braun — Z. physik. Chem. 33, 732, '00; Bohr and Bock — Wied. Ann. 44, 318, '91.)

t°	"Coefficient of Absorption" β.			"Solubility" B'.	q.
0	0.0235*	0.0239†	... ‡	0.0233*	0.00239*
5	0.0208	0.0215	0.0217	0.0206	0.00259
10	0.0186	0.0196	0.0200	0.0183	0.00230
15	0.0168	0.0179	0.0179	0.0165	0.00208
20	0.0154	0.0164	0.0162	0.0151	0.00189
25	0.0143	0.0150	0.0143	0.0139	0.00174
30	0.0134	0.0138	...	0.0128	0.00161
35	0.0125	0.0127	...	0.0118	0.00148
40	0.0118	0.0118	...	0.0110	0.00139
50	0.0109	0.0106	...	0.0096	0.00121
60	0.0102	0.0100	...	0.0082	0.00105
80	0.0096	...	...	0.0051	0.00069
100	0.0095	0.0100	...	0.0000	0.00000

\* W.

† B. and B.

‡ B.

For values of β, β', and q, see Ethane, p. 285.

Single determinations of the solubility of nitrogen in water reported by Hufner (1906-07), Bohr (1910), Müller (1912-13) and von Hammel (1915), are, on the average, about 2-3 units in the fourth place higher than the above figures of Winkler for the absorption coefficient β. Drucker and Moles (1910), give an extensive review of the literature and present results which, they state, are in very satisfactory agreement with previous determinations. A critical review of the literature of the solubility of nitrogen in water and in sea water is given by Coste (1917).

Data for the solubility of the nitrogen of air in water are given by Fox (1909a). The oxygen was removed from air and the solubility of the residual N + 1.185% argon was determined. After making correction for the argon, the following formula for the solubility of pure nitrogen in water was deduced:

$$1000 \times \text{coef. of abs. } \beta = 22.998 - 0.5298 t + 0.009196 t^2 - 0.00006779 t^3.$$

Data for the solubility of nitrogen in water at pressures up to 10 atmospheres are given by Cassuto (1913). The solubility was found to increase at a somewhat slower rate than proportional to the pressure.



## SOLUBILITY OF NITROGEN IN SEA WATER.

(Fox, 1909a).

Before using the sample of sea water for the solubility determinations it was found necessary to add acid, otherwise the  $\text{CO}_2$  could not be boiled out or the precipitation of neutral carbonates prevented. The very small amount of acid was titrated back, using phenolphthaleine as indicator.

The results are in terms of number of cc. of nitrogen (containing argon) absorbed by 1000 cc. of sea water from a free dry atmosphere of 760 mm. pressure. The calculated formula expressing the solubility is:

$$1000 a = 18.639 - 0.4304 t + 0.007453 t^2 - 0.0000549 t^3 \\ - Cl (0.2172 - 0.007187 t + 0.0000952 t^2).$$

Parts Chlorine per 1000.	0°.	4°.	8°.	12°.	16°.	20°.	24°.	28°.
0	18.64	17.02	15.63	14.45	13.45	12.59	11.86	11.25
4	17.74	16.27	14.98	13.88	12.94	12.15	11.46	10.89
8	16.90	15.51	14.32	13.30	12.44	11.70	11.07	10.52
12	16.03	14.75	13.66	12.72	11.93	11.25	10.67	10.16
16	15.18	14	13	12.15	11.73	10.81	10.27	9.80
20	14.31	13.27	12.34	11.57	10.92	10.36	9.87	9.44

A recalculation of Fox's determinations to parts per million, with correction for vapor pressure, is published by Whipple and Whipple (1911).

## SOLUBILITY OF NITROGEN IN AQUEOUS SOLUTIONS OF SULFURIC ACID

Results at 21°. (Bohr, 1910.)				Results at 20°. (Christoff, 1904)	
Normality of Aq. $\text{H}_2\text{SO}_4$ .	Absorption Coef. $\beta$ (Bunsen).	Normality of Aq. $\text{H}_2\text{SO}_4$ .	Absorp. Coef. $\beta$ (Bunsen).	Per cent $\text{H}_2\text{SO}_4$ .	Ostwald Solubility Expression $\alpha$ .
0	0.0156	24.8	0.0048	0	0.01537
4.9	0.0091	29.6	0.0051	35.82	0.008447
8.9	0.0072	34.3	0.0100	61.62	0.006144
10.7	0.0066	35.8*	0.0129	95.6	0.01672
20.3	0.0049				

\* = about 96%.

For definitions of Absorption Coef. (Bunsen) and Solubility Expression (Ostwald), see p. 227.

## SOLUBILITY OF NITROGEN IN AQUEOUS SALT SOLUTIONS.

(Braun.)

t°.	Coefficient of Absorption of N in Barium Chloride Solutions of:				
	13.83 Per cent.	11.92 Per cent.	6.90 Per cent.	3.87 Per cent.	3.33 Per cent.
5	0.0127	0.0137	0.0160	0.0180	0.0188
10	0.0117	0.0125	0.0147	0.0166	0.0166
15	0.0104	0.0114	0.0132	0.0148	0.0148
20	0.0092	0.0098	0.0118	0.0132	0.0132
25	0.0078	0.0086	0.0104	0.0114	0.0114

t°.	Coefficient of Absorption of N in Sodium Chloride Solutions of:				
	11.73 Per cent.	8.14 Per cent.	6.4 Per cent.	2.12 Per cent.	0.67 Per cent.
5	0.0102	0.0127	0.0138	0.0179	0.0188
10	0.0093	0.0113	0.0126	0.0164	0.0164
15	0.0081	0.0101	0.0113	0.0147	0.0147
20	0.0066	0.0087	0.0098	0.0131	0.0131
25	0.0047	0.0075	0.0083	0.0113	0.0113

## SOLUBILITY OF NITROGEN IN ALCOHOL.

(Bunsen.)

t°.	0°.	5°.	10°.	15°.	20°.
Vols. N * dissolved by 1 Vol. Alcohol.	0.1263	0.1244	0.1228	0.1214	0.1204

\* At 0° and 760 mm.



**SOLUBILITY OF NITROGEN IN MIXTURES OF ETHYL ALCOHOL AND WATER  
AT 25°.**  
(Just, 1901.)

Results in terms of the Ostwald solubility expression, see p. 227.

Vol. % H <sub>2</sub> O in Mixture.	Vol. % Alcohol in Mixture.	Dissolved N ( <i>l<sub>m</sub></i> ).
100	0	0.01634
80	20	0.01536
67	33	0.01719
0	100 (99.8% Alcohol)	0.1432

**SOLUBILITY OF NITROGEN IN SEVERAL SOLVENTS AT 20° AND 25°.**  
(Just.)

Solvent.	<i>l<sub>20</sub></i>	<i>l<sub>25</sub></i>	Solvent.	<i>l<sub>20</sub></i>	<i>l<sub>25</sub></i>
Water	0.01634	0.01705	Toluene	0.1235	0.1186
Aliline	0.03074	0.02992	Chloroform	0.1348	0.1282
Carbon Disulfide	0.05860	0.05290	Methyl Alcohol	0.1415	0.1348
Nitro Benzene	0.06255	0.06082	Ethyl Alcohol (99.8%)	0.1432	0.1400
Benzene	0.1159	0.1114	Acetone	0.1460	0.1383
Acetic Acid	0.1190	0.1172	Amyl Acetate	0.1542	0.1512
Xylene	0.1217	0.1185	Ethyl Acetate	0.1727	0.1678
Amyl Alcohol	0.1225	0.1208	Isobutyl Acetate	0.1734	0.1701

**SOLUBILITY OF NITROGEN IN PETROLEUM. COEFFICIENT OF ABSORPTION AT  
10° = 0.135, AT 20° = 0.117.**  
(Gniewasz and Walfisz, 1887.)

**SOLUBILITY OF NITROGEN IN AQUEOUS PROPIONIC ACID AND UREA  
SOLUTIONS.**  
(Braun.)

°.	Coefficient of Absorption of N in C <sub>2</sub> H <sub>5</sub> COOH Solutions of:				
	11.22 per cent.	9.54 per cent.	6.07 per cent.	4.08 per cent.	3.82 per cent.
5	0.0195	0.0204	0.0208	0.0210	0.0209
10	0.0178	0.0182	0.0186	0.0192	0.0191
15	0.0159	0.0163	0.0164	0.0169	0.0167
20	0.0146	0.0147	0.0148	0.0154	0.0155
25	0.0130	0.0134	0.0134	0.0137	0.0137

Coefficient of Absorption of N in CO(NH <sub>2</sub> ) <sub>2</sub> Solutions of:					
25.65 per cent.	11.9 per cent.	9.42 per cent.	6.90 per cent.	5.15 per cent.	2.28 per cent.
0.0175	0.0179	0.0190	0.0198	0.0197	0.0199
0.0162	0.0167	0.0176	0.0183	0.0182	0.0184
0.0150	0.0149	0.0158	0.0165	0.0165	0.0171
0.0140	0.0139	0.0146	0.0151	0.0151	0.0155
0.0130	0.0130	0.0133	0.0137	0.0135	0.0139



## SOLUBILITY OF NITROGEN IN AQUEOUS SOLUTIONS OF CHLORAL HYDRATE AT 15°

Results by Müller, C (1912-13.)			Results by von Hammel (1915).		
Gms. $\text{CCl}_3\text{CH}(\text{OH})_2$ per 100 Gms. Aq. Sol.	$d_{20}$ of Aq. Sol.	Absorp. Coef. $\beta$ at 15°.	Gms. $\text{CCl}_3\text{CH}(\text{OH})_2$ per 100 Gms. Aq. Sol.	Abs. Coef. $\beta$ at 15°.	Solubility $l_{25}$ (Ostwald).
0	1	0.0170	0	0.0170	0.01796
15.8	1.0738	0.0158	15	0.0152	0.0160
28.2	1.1422	0.01422	26.1	0.0141	0.0149
37.25	1.1946	0.01300	37.6	0.0123	0.0130
47	1.2535	0.01275	48.9	0.0115	0.0121
56.52	1.3225	0.01245	61.3	0.0114	0.0120
71.5	1.441	0.01420	70.9	0.0131	0.0138
78.8	1.503	0.01492	79.1	0.0156	0.0165

## SOLUBILITY OF NITROGEN IN AQUEOUS SOLUTIONS OF GLYCEROL.

Results of Müller, C. (1912-13).			Results of von Hammel (1915).		Results of Drucker and Moles (1910).		
Gms. (CH <sub>2</sub> OH) <sub>2</sub> CHOH per 100 Gms. Aq. Sol.	d <sub>18</sub> of Aq. Sol.	Abs. Coef. β at 15°.	Gms. (CH <sub>2</sub> OH) <sub>2</sub> CHOH per 100 Gms. Aq. Sol.	Abs. Coef. β at 15°.	Gms. (CH <sub>2</sub> OH) <sub>2</sub> CHOH per 100 Gms. Aq. Sol.	d <sub>20</sub> of Aq. Sol.	Solubility (Ostwald).
25	1.061	0.01266	15.7	0.01400	0	0	0.0156
42.2	1.108	0.00976	29.9	0.01087	16	1.0392	0.0103
51.5	1.133	0.00759	46.6	0.00840	29.7	1.0744	0.0067
58	1.151	0.00703	57.6	0.00698	48.9	1.1263	0.0052
80.25	1.212	0.00530	67.1	0.00635	74.5	1.1931	0.0025
90	1.240	0.00583	77	0.00527	84.1	1.2213	0.0024
95	1.249	0.00716	88.5	0.00536			
			99.25	0.00524			

Solubility of  $\text{N}_2$  in pure isobutyric acid of  $d_{25} = 0.9481$ ,  $l_{25}$  (Ostwald) = 0.1651. (Drucker and Moles, 1910.)

Solubility of  $\text{N}_2$  in aq. 37.5% isobutyric acid of  $d_{25} = 0.9985$ ,  $l_{25}$  (Ostwald) = 0.0396. (Drucker and Moles, 1910.)

Solubility of  $\text{N}_2$  in aq. 37.5% isobutyric acid of  $d_{25} = 0.9985$ ,  $l_{25}$  (Ostwald) = 0.0384. (Drucker and Moles, 1910.)

## SOLUBILITY OF NITROGEN IN AQUEOUS SOLUTIONS OF SEVERAL COMPOUNDS. (Hünner, 1906-07.)

Aq. Solution of:	Conc. of Aq. Solution.		t°.	Abs. Coef. $\beta$ .
	Normality.	Gms. per Liter.		
Glucose	1	180	20.18	0.01215
"	0.5	90	20.21	0.01380
"	0.25	45	20.2	0.01480
Alanine ( $\alpha$ Aminopropionic Acid)	1	89	20.19	0.01213
Glycocol (Aminoacetic Acid)	1	75	20.16	0.01212
Aribinose	1	150	20.21	0.01203
Levulose	1	180	20.25	0.01221
Erythritol	1	122	20.25	0.01321
Urea	1	60	20.18	0.01477
Acetamide	1	59	20.22	0.01475

## SOLUBILITY OF NITROGEN IN AQUEOUS SOLUTIONS OF CANE SUGAR AT 15°. (Müller, C., 1912-13.)

Gms. $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ per 100 Gms. Aq. Solution.	$d_{16}$ of Aq. Sol.	Abs. Coef. $\beta$ at 15°.	Gms. $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ per 100 Gms. Aq. Solution.	$d_{16}$ of Aq. Sol.	Abs. Coef. $\beta$ at 15°.
11.38	1.050	0.01480	30.12	1.129	0.01090
20	1.082	0.01280	47.80	1.220	0.00785
20.93	1.128	0.01053	48.57	1.223	0.00700

Data for the solubility of nitrogen in defibrinated ox-blood and ox serum under pressures varying 760-1400 mm. Hg are given by Findlay and Creighton (1910-11).

Data for the solubility of nitrogen in liquid oxygen are given by Erdman and Bedford (1904) and Stock (1904.)



**SOLUBILITY OF NITROGEN IN METHYL ALCOHOL SOLUTIONS OF POTASSIUM  
IODIDE AND OF UREA.**

(Levi, 1901.)

Solvent. Gms. KI or of Urea per 100 Gms. CH <sub>3</sub> OH Solution.	Solubility of N (in terms of the Ostwald Solubility Expression $l$ ).					
	At 5°.		At 15°.		At 25°.	
	$d_{10}$ of Solvent.	$l_5$	$d_{10}$ of Solvent.	$l_{15}$	$d_{20}$ of Solvent.	$l_{25}$
0 (=pure CH <sub>3</sub> OH)	0.8080	0.2154	0.7980	0.1923	0.7937	0.1649
2.152 KI	0.8171	0.2028	0.8070	0.1802	0.8019	0.1524
3.053 "	0.8249	0.1966	0.8015	0.1756	0.8101	0.1466
3.939 "	0.8930	0.1676	0.8841	0.1464	0.8801	0.1258
1.738 Urea	0.8148	0.2030	0.8050	0.1823	0.7997	0.1561
1.841 "	0.8231	0.1951	0.8122	0.1750	0.8080	0.1491
3.77 "	0.8350	0.1878	0.8241	0.1690	0.8193	0.1444

**SOLUBILITY OF NITROGEN IN ETHYL ETHER.**

(Christoff, 1912.)

Results in terms of the Ostwald expression  $l$  (see p. 227),  $l_5 = 0.2580$ ,  $l_{10} = 0.2561$ .

**ROGEN OXIDE (ic) NO.**

**SOLUBILITY IN WATER.**

(Winkler, 1901.)

$\beta$ .	$\beta'$ .	$q$ .	$t^\circ$ .	$\beta$ .	$\beta'$ .	$q$ .
0.0738	0.0734	0.00984	40	0.0351	0.0325	0.00440
0.0646	0.0641	0.00860	50	0.0315	0.0277	0.00376
0.0571	0.0564	0.00757	60	0.0295	0.0237	0.00324
0.0515	0.0506	0.00680	70	0.0281	0.0195	0.00267
0.0471	0.0460	0.00618	80	0.0270	0.0144	0.00199
0.0430	0.0419	0.00564	90	0.0265	0.0082	0.00114
0.0400	0.0384	0.00517	100	0.0263	0.0000	0.00000

$\kappa$  values of  $\beta$ ,  $\beta'$  and  $q$ , see Ethane, page 285.

**SOLUBILITY OF NITRIC OXIDE IN AQUEOUS SULPHURIC ACID SOLUTIONS  
AT 18°.**

(Lunge, 1885; Tower, 1906.)

per cent H <sub>2</sub> SO <sub>4</sub> in Solution.	Sp. Gr. at 15°.	Tension of H <sub>2</sub> O Vapor.	Solubility Coefficient * of NO at 18°.
98	1.84	...	0.0227 (0.035, L.)
90	1.82	0.1 mm.	0.0193
80	1.733	0.4 "	0.0117
70	1.616	1.5 "	0.0113
60	1.503	3.1 "	0.0118 (0.017, L.)
50	1.399	6.2 "	0.0120

\* Volume of NO (at 760 mm.) per 1 volume of aqueous H<sub>2</sub>SO<sub>4</sub>.

**SOLUBILITY OF NITRIC OXIDE IN ALCOHOL.**

(Bunsen.)

$t^\circ$	0°	5°	10°	15°	20°	24°
g. NO* dissolved by 1 vol. Alc.	0.316	0.300	0.286	0.275	0.266	0.261

\* At 0° and 760 mm.

Data for the solubility of nitric oxide in aqueous solutions of FeSO<sub>4</sub>, NiSO<sub>4</sub>, CoSO<sub>4</sub> and MnCl<sub>2</sub> at 20° are given by Usher (1908); Hüfner (1907) and Mant and Zecheulmayer (1906).

The abso. coef.  $\beta$  for N in sat. aq. NiSO<sub>4</sub> at 20° is 0.0245; for sat. CoSO<sub>4</sub> it is 0.0188 and for sat. aq. MnCl<sub>2</sub> it is 0.0082.



# NITROGEN OXIDE

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## NITROUS OXIDE $N_2O$ .

### SOLUBILITY IN WATER.

(Bunsen; Roth, 1897; Knopp, 1904; Geffcken, 1904.)

t°.	Coefficient of Absorption $\beta$		g.	Solubility in Terms of Ostwald Expression (l).*		
	(B.)	(R.)		(R.)	(K.)	(G.)
5	1.0954	1.1403	0.205	1.161	...	1.067
10	0.9196	0.9479	0.171	0.9815	...	0.9101
15	0.7778	0.7896	0.143	0.8315	...	0.7784
20	0.6700	0.6654	0.121	0.7131	0.6739	0.6750
25	0.5961	0.5752	0.104	0.6281	...	0.5942

\* Calculated by Geffcken.

For definitions of  $\beta$  and  $g$ , see p. 285; for  $l$ , see p. 227.

NOTE. — Knopp and also Geffcken call attention to the fact that Roth in making his determinations used a rubber tube between the gas burette and the shaking flask, and give this as an explanation of the high results which he obtained.

### SOLUBILITY OF NITROUS OXIDE IN AQUEOUS SULPHURIC ACID.

(Lunge — Ber. 14, 2188, '81; see also Geffcken's results.)

Sp. Gr. of $H_2SO_4$	1.84	1.80	1.705	1.45	1.35
Vols. $N_2O$ dissolved by 100 vols. $H_2SO_4$	75.7	66.0	39.1	41.6	33.0

100 vols. of KOH solution of 1.12 Sp. Gr. absorb 18.7 vols.  $N_2O$ .  
100 vols. of NaOH solution of 1.10 Sp. Gr. absorb 23.1 vols.  $N_2O$ .

### SOLUBILITY OF NITROUS OXIDE IN AQUEOUS SOLUTIONS OF ACIDS. (Geffcken.)

Results in terms of the Ostwald Solubility Expression (l). See p. 227.

In Hydrochloric Acid.			In Nitric Acid.			In Sulphuric Acid		
Gms. HCl per Liter.	$N_2O$ Dissolved $l_{15}$	$l_{25}$	Gms. $HNO_3$ per Liter.	$N_2O$ Dissolved $l_{15}$	$l_{25}$	Gms. $H_2SO_4$ per Liter.	$N_2O$ Dissolved $l_{15}$	$l_{25}$
18.22	0.755	0.577	36.52	0.777	0.597	24.52	0.734	0.55
36.45	0.738	0.568	63.05	0.777	0.602	49.04	0.699	0.5
72.90	0.716	0.557	126.10	0.775	0.611	98.08	0.645	0.5
						147.12	0.602	0.4
						196.16	0.562	0.4

### SOLUBILITY OF NITROUS OXIDE IN AQUEOUS SOLUTIONS OF ACIDS. (Roth.)

#### Phosphoric Acid.

Coefficient of Abs. in  $H_3PO_4$  Solutions of:

t°	3.38%.	4.72%.	8.84%.	9.89%.	13.35%.
5	1.057	1.0365	0.9883	0.9635	0.9171
10	0.8827	0.8665	0.8296	0.8101	0.7711
15	0.7388	0.7258	0.6977	0.6826	0.6505
20	0.6253	0.6147	0.5926	0.5810	0.5555
25	0.5427	0.5329	0.5143	0.5054	0.4860

#### Oxalic Acid.

Coefficient of Abs. in  $(COOH)_2$  Solution of:

t°	0.812%.	3.70%.
5	1.1450	1.1
10	0.9526	0.9
15	0.7940	0.7
20	0.6694	0.6
25	0.5784	0.5



OF NITROUS OXIDE IN AQUEOUS SOLUTIONS OF PROPIONIC  
ACID AT 20°.  
(Knopp.)

OH	15.15	60.42	158.4	176.6	344.0
P	0.6323	0.6369	0.6504	0.6534	0.7219

TY OF NITROUS OXIDE IN AQUEOUS SALT SOLUTIONS.

y Geffcken in terms of the Ostwald expression (1). See

	Formula.	Conc. of Salt per Liter.		Solubility of N <sub>2</sub> O.	
		Gram Equiv.	Grams.	l <sub>18</sub> .	l <sub>28</sub> .
a Chloride	NH <sub>4</sub> Cl	0.5	26.76	0.730	0.557
a Chloride	NH <sub>4</sub> Cl	1.0	53.52	0.691	0.529
hloride	CsCl	0.5	84.17	0.710	0.544
hloride	LiCl	0.5	21.24	0.697	0.535
hloride	LiCl	1.0	42.48	0.623	0.483
Bromide	KBr	0.5	59.55	0.697	0.536
Bromide	KBr	1.0	119.11	0.627	0.485
Chloride	KCl	0.5	37.3	0.686	0.527
Chloride	KCl	1.0	74.6	0.616	0.475
Iodide	KI	0.5	83.06	0.702	0.541
Iodide	KI	1.0	166.12	0.633	0.492
Hydroxide	KOH	0.5	28.08	0.668	0.514
Hydroxide	KOH	1.0	56.16	0.559	0.436
Chloride	RbCl	0.5	60.47	0.695	0.533
Chloride	RbCl	1.0	120.95	0.625	0.483

y Knopp, in terms of the coefficient of absorption. See

	Formula.	Conc. of Salt per Liter.		Coef. of Absorption of N <sub>2</sub> O at 20°.
		Normality.	Grams.	
Nitrate	KNO <sub>3</sub>	0.1061	10.74	0.6173
"	"	0.2764	27.94	0.6002
"	"	0.5630	56.97	0.5713
"	"	1.1683	118.2	0.5196
rate	NaNO <sub>3</sub>	0.1336	11.37	0.6089
"	"	0.3052	25.97	0.5876
"	"	0.6286	53.50	0.5465
"	"	1.1200	95.30	0.4926

· Roth, in terms of the coefficient of absorption.

per	Coefficient of Absorption of N <sub>2</sub> O at:				
	5°.	10°.	15°.	20°.	25°.
	1.0609	0.8812	0.7339	0.6191	0.5363
	1.0032	0.8383	0.7026	0.5962	0.5190
	0.9131	0.7699	0.6495	0.5520	0.4775
	0.8428	0.7090	0.5976	0.5088	0.4424



## SOLUBILITY OF NITROUS OXIDE IN AQUEOUS SALT SOLUTIONS.

Results by Gordon in terms of coefficient of absorption. — See p. 227.

Salt.	Concentration of Salt.		Coefficient of Absorption of $\text{N}_2\text{O}$ at:			
	Grams per 100 Grams Solution.	Gram Mols. per Liter.	5°.	10°.	15°.	20°.
Calcium Chloride	5.79	0.547	0.819	0.697	0.591	0.500
"	9.86	0.964	0.668	0.586	0.509	0.435
"	13.99	1.416	0.510	0.441	0.380	0.328
Lithium Chloride	1.35	0.319	0.986	0.831	0.700	0.594
"	3.85	0.928	0.878	0.743	0.629	0.536
"	11.48	2.883	0.606	0.512	0.437	0.382
Lithium Sulphate	2.37	0.219	0.934	0.792	0.670	0.569
"	5.46	0.521	0.795	0.665	0.557	0.474
"	8.56	0.836	0.646	0.555	0.477	0.415
Magnesium Sulphate	5.90	0.521	0.766	0.664	0.561	0.471
"	7.66	0.687	0.708	0.586	0.488	0.414
"	10.78	0.997	0.569	0.491	0.417	0.346
Potassium Chloride	4.90	0.676	0.879	0.751	0.643	0.555
"	7.64	1.037	0.799	0.693	0.591	0.494
"	14.58	2.147	0.654	0.574	0.500	0.430
"	22.08	3.414	0.544	0.459	0.390	0.339
Potassium Sulphate	2.62	0.154	0.986	0.831	0.701	0.605
"	4.78	0.285	0.918	0.763	0.637	0.542
Sodium Chloride	6.20	1.107	0.800	0.682	0.585	0.509
"	8.88	1.614	0.713	0.603	0.510	0.434
"	12.78	2.391	0.634	0.532	0.449	0.386
Sodium Sulphate	5.76	0.427	0.808	0.677	0.584	0.495
"	8.53	0.646	0.692	0.574	0.482	0.416
"	12.44	0.974	0.559	0.486	0.417	0.354
Strontium Chloride	3.31	0.215	0.928	0.788	0.671	0.578
"	5.73	0.380	0.848	0.709	0.610	0.550
"	13.24	0.939	0.644	0.547	0.463	0.390

## SOLUBILITY OF NITROUS OXIDE IN ALCOHOL AND IN AQUEOUS CHLORAL HYDRATE SOLUTIONS AT 20°.

(Bunsen; Knopp — Z. physik. Ch. 48, 106, '04.)

t°.	In Alcohol (B.).		In Aq. Chloral Hydrate (K.).	
	Vols. $\text{N}_2\text{O}$ (at 0° and 760 mm.) per 1 Vol. Alcohol.	Normality of $\text{C}_2\text{HCl}_3\text{O} \cdot \text{H}_2\text{O}$ .	Gms. $\text{C}_2\text{HCl}_3\text{O} \cdot \text{H}_2\text{O}$ per Liter.	Coef. of Abs. of $\text{N}_2\text{O}$ .
0	4.178	0.184	30.43	0.618
5	3.844	0.445	73.60	0.613
10	3.541	0.942	155.8	0.596
15	3.268	1.165	192.7	0.589
20	3.025	1.474	243.8	0.579
24	2.853	1.911	316.4	0.567

## SOLUBILITY OF NITROUS OXIDE IN PETROLEUM. COEFFICIENT OF ABSORPTION AT 10° = 2.49, AT 20° = 2.11.

(Gniewasz and Walfisz — Z. physik. Ch. 1, 70, '87.)



### NITROUS OXIDE IN AQUEOUS SOLUTIONS OF GLYCEROL AND OF UREA.

(Roth, 1897.)

Coefficient of Absorption of  $N_2O$  in Glycerol Solutions of:

3.46 Per cent.	6.73 Per cent.	12.12 Per cent.	16.24 Per cent.
1.097	1.055	0.999	0.959
0.917	0.887	0.841	0.810
0.767	0.745	0.710	0.686
0.647	0.630	0.605	0.585
0.556	0.542	0.527	0.508

Coefficient of Absorption of  $N_2O$  in Urea Solutions of:

per cent.	4.97 per cent.	6.37 per cent.	7.30 per cent.	9.97 per cent.
104	1.096	1.088	1.101	1.069
921	0.920	0.909	0.921	0.901
771	0.773	0.761	0.772	0.761
653	0.656	0.644	0.655	0.651
569	0.567	0.559	0.570	0.569

### OF NITROUS OXIDE IN AQUEOUS SOLUTIONS OF GLYCEROL.

(Henkel, 1905, 1912.)

Results at 15°.

Results at 20°.

glycerol.	Absorption Coef. $\alpha$ .	Per cent Glycerol.	Absorption Coef. $\alpha$ .
	0.7327	0	0.6288
9	0.7181	2.36	0.6131
8	0.7103	4.88	0.5993
7	0.6844	6.88	0.5903
2	0.6668	9.86	0.5633
15	0.6410	15.82	0.5315
8	0.6229		

the influence of colloids and fine suspensions on the solubility of nitrous oxide in water at 25° are given by Findlay and Creighton (1910), and Findlay (1914).

Solubilities of ferric hydroxide, dextrin, arsenious sulfide, starch, gelatin, egg albumen, serum albumen, silicic acid and suspensions of ferric silica are given.

Solubilities of nitrous oxide in blood are given by Siebeck (1909) and by Findlay and Creighton (1910-11).

### TETROXIDE $NO_2$ .

Solubilities of nitrogen tetroxide in ferrous bromide solutions are given by Siebeck (1896).

Experimental data (solubility, see footnote, p. 1), are given for mixtures by v. Wittorff (1904), and for mixtures of  $NO_2$  + *o*-Nitrotoluene

### ULOSE (Soluble Pyroxylin, Tetra and Penta Nitrate).

#### SOLUBILITY IN ETHER-ALCOHOL MIXTURES.

(Matteoschat, 1914; see also Stepanow, 1907.)

Gun cotton containing 12.95% N was used. The compound was dissolved in ethyl alcohol and then the amount of ether to yield the desired concentration was added. Lower results were obtained with ready prepared mixtures.

Gms. Gun Cotton Dissolved per 100 Gms. Solution in Mixtures Prepared with:

99.5 Vol. % Alcohol.	95 Vol. % Alcohol.	90 Vol. % Alcohol.	80 Vol. % Alcohol.
34.4	...	...	...
52.3	42.3	28.7	14.2
40.5	52.4	53.9	45
25	42.4	53	57.5



# NOVOCAINE

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**NOVOCAINE** (base)  $\text{CH}_3(\text{C}_6\text{H}_4\text{NH}_2\text{COO})\text{CH}_2[\text{N}(\text{C}_2\text{H}_5)_2] \cdot 2\text{H}_2\text{O}$ .

100 cc.  $\text{H}_2\text{O}$  dissolve 0.333 gm. anhydrous novocaine at  $20^\circ$ .

100 cc. oil of sesame dissolve 4.29 gms. anhydrous novocaine at  $20^\circ$  — (Zaki,

**NOVOCAINE** (Hydrochloride)  $\text{CH}_3(\text{C}_6\text{H}_4\text{NH}_2\text{COO}) \cdot \text{CH}_2[\text{N}(\text{C}_2\text{H}_5)_2] \cdot \text{HCl}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve about 100 gms. of the salt at room temp.

100 gms. alcohol dissolve about 3 gms. of the salt at room temp.

**OCTANE**  $\text{CH}_3(\text{CH}_2)_6\text{CH}_3$ .

## RECIPROCAL SOLUBILITY OF OCTANE AND PHENOL.

(Campetti and Del Grosso, 1913.)

t°.	Gms. Phenol per 100 Gms. Mixture.	t°.	Gms. Phenol per 100 Gms. Mixture.
22.55	13.28	49.5 crit. t.	52 .2
37.85	22.74	49.35	52 .37
38.15	23.53	44.7	71 .14
44.70	32.85	30.65	82 .01
47.75	41.72	19.65	85 .99

**OLEIC ACID**  $\text{C}_{18}\text{H}_{33}\text{O}_2$ .

## SOLUBILITY OF OLEIC ACID IN AQUEOUS ALCOHOL SOLUTIONS AT $25^\circ$ .

(Seidell, 1910.)

Oleic acid of  $d_{25} = 0.8935$  and containing 99.5% acid, determined by titration, was used. It was found that the addition of as little as one drop of this acid to aq. alcohol solutions containing up to 50 wt. %  $\text{C}_2\text{H}_5\text{OH}$  caused an opalescence on shaking, therefore, indicating a solubility of less than about 0.05 gm. acid per 100 cc. water or of aq. alcohol. With solutions containing more than 50 wt. %  $\text{C}_2\text{H}_5\text{OH}$  the following results were obtained:

Wt. Per cent $\text{C}_2\text{H}_5\text{OH}$ .	cc. Oleic Acid per 100 cc. Aq. Alcohol to produce cloudiness.	Remarks.
51	0.08—0.2	Cloudiness gradually increased.
58.2	0.2 — 0.4	" " "
65.5	0.3 — 0.6	Cloudiness disappeared when about 5.5 cc. acid had been added.
70.2	0.6 — 1	" " " " 4.5 cc. " " "
81.4	∞	No cloudiness appeared at all.

It was found that although the end points obtained by addition of oleic acid to aq. alcohol mixtures are not sharp, they become so when the procedure is changed to addition of  $\text{H}_2\text{O}$  to mixtures of oleic acid and alcohol. By this method perfectly clear liquid may be transformed by one drop of the  $\text{H}_2\text{O}$  to an opalescent mixture which, after standing a few minutes, separates into two liquid layers. Determinations made in this way gave the following observed and calculated quantities.

Gms. of Constituents to Yield Opalescent Mixtures.			Results Calculated from the Plotted Curve.		
Alcohol + Oleic Acid Mixture.	$\text{H}_2\text{O}$ Added to Cause Separation.		Wt. Per cent $\text{C}_2\text{H}_5\text{OH}$ in Aq. Alcohol.	cc. Oleic Acid per 100 cc. Aq. Alcohol.	Gms. Oleic per 100 Gm. Sol.
$\text{C}_2\text{H}_5\text{OH}$ .	Oleic Acid.				
15.30	1.794	10.4	57	...	0
15.30	3.588	10.2	58.5	0	5
15.30	4.485	9.8	60	11	12.3
15.30	7.175	9.25	62.5	30	20
15.30	11.210	8.05	65	49	30.5
24.42	22.420	10.10	67.5	69	40
15.30	20.810	6.50	70	91	50
1.195	8.969	0.321	75.5	...	68.5
			80	...	88

After standing 24 hours the opalescent mixtures separated into layers which on analysis, gave the results shown in the following table:



DISTRIBUTION OF UPPER AND LOWER LAYERS OBTAINED BY THE ADDITION OF TER TO MIXTURES OF AQUEOUS ALCOHOL AND OLEIC ACID AT 25°. (Con. a p. 466).

Position of Original Mixture.

After Separation into Two Layers:

cc. Aq. Alcohol Mixture.	cc. Oleic Acid.	cc. H <sub>2</sub> O to Cause Separation.	Lower Layer.			Upper Layer.		
			cc. Total Vol.	Sp. Gr.	cc. Oleic Acid.	cc. Total Vol.	Sp. Gr.	cc. Oleic Acid.
25	2	3.90	29	0.893	1.48	1	...	0.35
25	4	3.70	26	0.890	1.89	6	0.875	1.98
26.5	5	1.75	22.7	0.891	1.93	9.3	0.875	2.78
25	8	2.75	16	0.893	0.98	19	0.876	6.59
25	12.5	1.55	6	0.890	0.37	33.2	0.878	11.87
35	25	1	4.5	...	0.28	55.5	0.877	24.14

C<sub>2</sub>H<sub>5</sub>OH in the two layers could not be determined on account of excessive loss during distillation of the neutralized solution. Some losses occurred in transferring the original mixtures to the graduated cylinders and differences in final amounts and those originally present are due to these losses.

SOLUBILITY OF OLEIC ACID IN AQUEOUS SOLUTIONS OF BILE SALTS.

(Moore, Wilson and Hutchinson, 1909.)

Solvent.

Gms. Oleic Acid per 100

Gms. Sat. Sol.

less than 0.1

about 0.5

4

Water

5% Aq. Solution of Bile Salts

5% Aq. Solution of Bile Salts + 1% Lecithin

DISTRIBUTION OF OLEIC ACID BETWEEN AQUEOUS ALCOHOL AND BENZINE. (Holde, '10.)

Gm. (Approx.) of Oleic Acid in:

Strength of Aq. Alcohol in Vol. Per cent.	50 cc. Aq. Alcohol Layer.	50 cc. Benzine Layer.	Dist. Coef.
84.1	0.277	0.723	2.61
76.9	0.112	0.888	7.93
63.7	0.025	0.975	39
50.5	0.006	0.994	166
42.4	0.002	0.998	499

SOLIDIFICATION-POINTS OF MIXTURES OF OLEIC AND STEARIC ACIDS. (Meldrum, '13.)

Solidification Temp.	Per cent Oleic Acid in Mixture.	Solidification Temp.	Per cent Oleic Acid in Mixture.
0	54.8	50	44.7
10	53.3	60	41.2
20	51.6	70	36.6
30	49.7	80	30.5
40	47.6		

Additional data for the above system as well as for mixtures of oleic and stearic acids and for the ternary system oleic, palmitic and stearic acids are given by Carlinfante and Levi-Malvano (1909). Results for Oleic Acid + Stearic Acid are also given by Fokin (1912).

TRIOLEIN (C<sub>57</sub>H<sub>102</sub>O<sub>6</sub>)<sub>2</sub>C<sub>57</sub>H<sub>102</sub>O<sub>6</sub>.

SOLIDIFICATION-POINTS OF MIXTURES OF TRIOLEIN AND OTHER FATS.

(Kremann and Schoultz, 1912.)

Oleoin + Tripalmitin.	Triolein + Tristearin.	Tripalmitin + Tristearin.
t°. Wt. Per cent Triolein.	t°. Wt. Per cent Triolein.	t°. Wt. Per cent Tristearin.
7 100	+28 95.2	60.4 90
15 93.9	44 85.3	58 75
18.2 78.5	50.7 76.7	57.8 69.4
50 73.9	56 68.8	56 60.2
56.9 53	64.3 47.2	57.2 53
50.9 27.2	64.3 25.4	55.1 43.8
52.6 0	56 0	54.5 31.2
		60.4 8.4

Results for the ternary system, triolein, tripalmitin and tristearin are also given.



## OILS. (See also Fats, p. 302.)

SOLUBILITY OF SEVERAL OILS IN ALCOHOL ( $d_{15} = 0.795$ ) AT 14-15°  
(Davidsohn and Wrage, 1915.)

Oil.	Gms. Oil per 100 Gms. Sat. Sol.
Linseed Oil	3.32
Rape Oil	1.36
Cotton Seed Oil	3.61
Olive Oil	2.25

Results are also given for the solubility of mixtures of oils and fatty acids in alcohol. The following results at 22°, in terms of approx. volume of oil dissolved by 100 volumes of 80% alcohol, are given by Aubert (1902). Nigella oil, 4.3; oil of boldo leaves, more than 100; matico oil, about 20; cascarrilla oil, 5; weld-mint oil, 66.

Miscibility curves for various oils with acetone, petroleum and aniline are given by Louise (1911). The use of this data for the identification of oils and the detection of adulterants in them is described.

An extensive series of observations on the solubility of water in oils and on the water content of various oils is given by Umney and Bunker (1912).

Freezing-point data for oil of helianthus annus + stearic acid are given by Fokin (1912).

**OSMIC ACID**  $\text{OsO}_4$ , 100 gms.  $\text{H}_2\text{O}$  dissolve 5.88 gms. Osmic Acid at about 15° (Squire and Caine, 1905.)

**OXALIC ACID**  $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Koppel and Cahn, 1908; for older data see Alluard, Miczynski, 1886; Lamouroux, 1899.)

t°.	Gms. $\text{H}_2\text{C}_2\text{O}_4$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{H}_2\text{C}_2\text{O}_4$ per 100 Gms. Sat. Sol.	Solid Phase.
- 0.064	0.1805	Ice	20	8.69	$\text{H}_2\text{C}_2\text{O}_4$
- 0.152	0.452	"	30	12.46	"
- 0.533	1.820	"	40	17.71	"
- 0.936	3.291	"	50	23.93	"
- 1.50	5.836	"	60	30.71	"
- 0.95	3.302	$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$	70	37.92	"
0	3.416	"	80	45.80	"
+ 10	5.731	"	90.2	54.67	"

$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$  melts in its  $\text{H}_2\text{O}$  of crystallization at 98°.

SOLUBILITY OF OXALIC ACID IN AQUEOUS HCl AND IN AQUEOUS  $\text{HNO}_3$  AT 30°  
(Masson, 1912.)

## In Aq. Hydrochloric Acid.

G. Mols. HCl per liter Sat. Sol.	$d_{25}$ Sat. Sol.	G. Mols. $(\text{COOH})_2$ per liter Sat. Sol.	Gms. $(\text{COOH})_2$ per liter Sat. Sol.
0	1.0594	1.479	133.1
0.503	1.0561	1.190	107.1
0.970	1.0577	1.032	92.85
1.939	1.0654	0.821	73.88
2.959	1.0757	0.675	60.74
4.528	1.0957	0.555	49.95
6.026	1.1165	0.525	47.25
7.907	1.1494	0.607	54.63
9.680	1.1843	0.871	78.38

## In Aq. Nitric Acid.

G. Mols. $\text{HNO}_3$ per liter Sat. Sol.	$d_{25}$ Sat. Sol.	G. Mols. $(\text{COOH})_2$ per liter Sat. Sol.	Gms. $(\text{COOH})_2$ per liter Sat. Sol.
0.478	1.0648	1.268	114
1.606	1.0932	1.039	93
4.224	1.1666	0.790	71
9.590	1.3074	0.639	57
13.62	1.3938	0.847	76
14.12	1.4060	0.966	86
15.59	1.4319	1.114	100
16.92	1.4443	0.840	75
20.84	1.4819	0.524	47
21.63	1.4917	0.553	49

SOLUBILITY OF OXALIC ACID IN AQUEOUS SOLUTIONS OF  $\text{H}_2\text{SO}_4$  AT 25°. (Wirtz, 1904.)

Conc. of Aq. $\text{H}_2\text{SO}_4$ Normality.	$d_{25}$ of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.	Conc. of Aq. $\text{H}_2\text{SO}_4$ Normality.	$d_{25}$ of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.
0	1.047	0	4.85	1.157	14
1	1.064	2.98	5.67	1.177	16.44
2.39	1.140	7.30	6.45	1.220	17.84
4.36	1.146	12.57	8.9	1.280	25.92



**SOLUBILITY OF OXALIC ACID IN SEVERAL ALCOHOLS.**  
(Timofeiew, 1894.)

Alcohol.	t°.	Gms. (COOH) <sub>2</sub> per 100 Gms. Sat. Sol.	Alcohol.	t°.	Gms. (COOH) <sub>2</sub> per 100 Gms. Sat. Sol.
Alcohol	- 1.5	34.2	Propyl Alcohol	- 1.5	12.2
"	+20.2	39.8	"	+18.5	16.7
Alcohol	- 1.5	22.4	"	20.2	17.5
"	+18.5	26.2	Isobutyl Alcohol	20.2	10.9
"	20.2	26.9			

**SOLUBILITY OF OXALIC ACID IN ABSOLUTE AND IN AQUEOUS ETHER AT 25°.**  
(Bödtker, 1897; Bourgoin.)

ns. absolute ether dissolve 1.47 gms. (COOH)<sub>2</sub>·2H<sub>2</sub>O.  
ns. absolute ether dissolve 23.59 gms. (COOH)<sub>2</sub>.

**In Aqueous Ether Solutions.**

Acid Added per 100 cc. Ether Solution.		Gms. per 100 cc. Ether Solution.	
(OH) <sub>2</sub> ·2H <sub>2</sub> O.	(COOH) <sub>2</sub> .	H <sub>2</sub> O.	(COOH) <sub>2</sub> .
(1) 5	0	1.250	0.742
(2) 5	0	0.788	0.720
5	0	0.418	1.044
5	2.44	0.360	3.388
5	4.82	0.484	6.038
5	7.14	0.558	8.538
5	9.42	0.632	10.996
5	11.63	0.676	13.316
5	13.79	0.760	15.684
5	18.18	0.816	17.818
5	22.73	0.816	17.818

(1) Ether saturated with water.

(2) Ether containing 0.694 per cent water.

ns. glycerol dissolve 15 gms. oxalic acid at 15.5°. (Ossendowski, 1907.)

ns. 95% formic acid dissolve 9.74 gms. anhydrous oxalic acid at 16.8°. (Aschan, 1913.)

**DISTRIBUTION OF OXALIC ACID BETWEEN WATER AND AMYL ALCOHOL AT 20°.**  
(Herz and Fischer, 1904.)

Millimols $\frac{1}{2}$ (COOH) <sub>2</sub> per 10 cc.		Gms. (COOH) <sub>2</sub> per 100 cc.	
Aq. Layer.	Alcoholic Layer.	Aq. Layer.	Alcoholic Layer.
0.6806	0.1451	0.306	0.0653
2.364	0.7233	1.064	0.326
6.699	2.550	3.015	1.148
10.029	4.300	4.511	1.934

For the distribution of oxalic acid between mixtures of amyl alcohol + water at 25° are given by Herz and Kurzer (1910).

**DISTRIBUTION OF OXALIC ACID BETWEEN WATER AND ETHER.**  
(Pinnow, 1915.)

Results at 15°.			Results at 27°.		
(COOH) <sub>2</sub> per Liter.	Dist. Coef. of:		Gm. Mols. (COOH) <sub>2</sub> per Liter.	Dist. Coef. of:	
Ether Layer.	Total Acid.	Undissoc. Acid.	Water Layer.	Ether Layer.	Total Acid.
0.02945	11.6	8.49	0.760	0.0637	11.9
0.01395	13.5	8.81	0.561	0.0433	13
0.00845	14.8	8.69	0.3575	0.0250	14.3
0.00553	16.1	8.72	0.2550	0.0165	15.5
0.00248	19	8.19	0.1754	0.01025	17.1
0.0022	19.8	8.26			7.94

or the effect of H<sub>2</sub>SO<sub>4</sub> upon the above distribution are also given.

Similar to the above for a greater range of conc. at 25° are given by (1908).



OXYGEN O<sub>2</sub>.

SOLUBILITY IN WATER. (Winkler, 1891; Bohr and Bock, 1891.)

t°.	Coef. of Absorption $\beta$ .		g.	cc. O per Liter H <sub>2</sub> O.	t°.	Coef. of Absorption $\beta$ .		g.
0	0.0489*	0.0496†	0.00695	10.187	40	0.0231*	0.0233†	0.00308
5	0.0429	0.0439	0.00607	8.907	50	0.0209	0.0207	0.00266
10	0.0380	0.0390	0.00537	7.873	60	0.0195	0.0189	0.00227
15	0.0342	0.0350	0.00480	7.038	70	0.0183	0.0178	0.00186
20	0.0310	0.0317	0.00434	6.356	80	0.0176	0.0172	0.00138
25	0.0283	0.0290	0.00393	5.776	90	0.0172	0.0169	0.00079
30	0.0261	0.0268	0.00359	5.255	100	0.0170	0.0168	0.00000

\* W.

† B. and B.

For values of  $\beta$  and  $q$  see Ethane, p. 285.

According to determinations by Fox (1909a), which agree satisfactorily with the above, the solubility of oxygen in water is expressed by the formula:

$$1000 \times \text{abs. coef. } \beta = 49.239 - 1.3440t + 0.28752t^2 - 0.0003024t^3.$$

References to more recent papers on the solubility of oxygen are given by Coste (1927, 1918).

## SOLUBILITY OF THE OXYGEN OF AIR IN WATER.

t°.	5.2°.	5.65°.	14.78°.	24.8°.
Solubility *	8.856	8.744	7.08	5.762

\* cc. Oxygen per 1000 cc. H<sub>2</sub>O saturated with air at 760 mm.

## SOLUBILITY OF OXYGEN IN WATER AND IN AQUEOUS SOLUTIONS OF BASES AND SALTS. (Geffcken, 1904.)

Aq. Solution of:	Concentration per Liter.		Solubility of Oxygen.	
	Gram Equiv.	Grams.	15°.	16°.
Water alone	...	...	0.0363	0.0308
Hydrochloric Acid	0.5	18.22	0.0344	0.0296
"	1.0	36.45	0.0327	0.0287
"	2.0	72.90	0.0299	0.0267
Nitric Acid	0.5	36.52	0.0348	0.0302
"	1.0	63.05	0.0336	0.0295
"	2.0	126.10	0.0315	0.0284
Sulphuric Acid	0.5	24.52	0.0338	0.0288
"	1.0	49.04	0.0319	0.0275
"	2.0	98.08	0.0335	0.0251
"	3.0	147.12	0.0256	0.0221
"	4.0	196.16	0.0233	0.0201
"	5.0	245.20	0.0213	0.0191
Potassium Hydroxide	0.5	28.08	0.0291	0.0251
"	1.0	56.16	0.0234	0.0206
Sodium Hydroxide	0.5	20.03	0.0288	0.0250
"	1.0	40.06	0.0231	0.0204
"	2.0	80.12	0.0152	0.0133
Potassium Sulphate	0.5	43.59	0.0294	0.0253
"	1.0	87.18	0.0237	0.0207
Sodium Chloride	0.5	29.25	0.0308	0.0262
"	1.0	58.5	0.0260	0.0223
"	2.0	119.0	0.0182	0.0158

\* In terms of the Ostwald Solubility Expression. See page 227.

## SOLUBILITY OF OXYGEN IN AQUEOUS POTASSIUM CYANIDE SOLUTIONS (MacLaurin, 1893.)

Gms. KCN per 100 gms. sol.	1	10	20	30
Coefficient of absorption $\beta$	0.029	0.018	0.013	0.008



## SOLUBILITY OF OXYGEN IN SEA WATER.

(Fox, 1909a.)

using the sample of sea water for the solubility determinations, it was necessary to add acid, otherwise the  $\text{CO}_2$  could not be boiled out or the ion of neutral carbonates prevented. The very small amount of acid added back, using phenolphthaleine as indicator.

in terms of cc. of oxygen absorbed by 1000 cc. of sea water from a atmosphere at 760 mm. pressure.

calculated formula expressing the solubility is:  $1000 a = 10.291 - 0.2809 t + 0.000632 t^2 - C(0.1161 - 0.003922 t + 0.0000631 t^2)$ .

barine cc.	$t=0^\circ$ .	4°.	8°.	12°.	16°.	20°.	24°.	28°.
	10.29	9.26	8.40	7.68	7.08	6.57	6.14	5.75
	9.83	8.85	8.04	7.36	6.80	6.33	5.91	5.53
	9.36	8.45	7.68	7.04	6.52	6.07	5.67	5.31
	8.90	8.04	7.33	6.74	6.24	5.82	5.44	5.08
	8.43	7.64	6.97	6.43	5.96	5.56	5.20	4.86
	7.97	7.23	6.62	6.11	5.69	5.31	4.95	4.62

ulation of Fox's determinations to parts per million, with correction pressure, is published by Whipple and Whipple (1911).

onal data on the solubility of atmospheric oxygen in sea water are Clowes and Biggs (1904).

or the solubility of oxygen in water under pressures up to 10 atmos-e given by Cassuto (1913). The solubility increases at a somewhat te than proportional to the pressure.

## SOLUBILITY OF OXYGEN IN AQUEOUS SALT SOLUTIONS AT 25°.

(MacArthur, 1916.)

	$d_4^25$ Aq. Solution.	cc. oxy- gen per Liter.	Aq. Salt Solution.	$d_4^25$ Aq. Solution.	cc. Oxy- gen per Liter.	Aq. Salt Solution.	$d_4^25$ of Solution.	cc. Oxy- gen per Liter.
	1	5.78	0.25 % KBr	1.019	5.29	0.125% NaBr	1.007	5.65
Cl	1.0015	2.31	2 % "	1.079	3.27	0.25 % "	1.017	5.52
	1.0025	1.16	4 % "	1.162	1.84	0.50 % "	1.036	5.15
	1.014	0.07	0.125% KCl	1.003	5.52	1 % "	1.075	4.47
K	1.019	5.40	0.25 % "	1.0086	5.30	2 % "	1.150	3.37
	1.042	5.04	0.50 % "	1.020	4.98	3 % "	1.219	2.57
	1.082	4.27	1 % "	1.042	4.26	4 % "	1.305	2.02
	1.177	3.10	2 % "	1.086	3.21	6 % "	1.455	1.28
Na	1.022	5.08	3 % "	1.134	2.36	0.125% NaCl	1.0022	5.52
	1.084	3.71	4 % "	1.170	1.86	0.25 % "	1.0067	5.30
	1.34	2.14	0.125% KI	1.013	5.65	0.50 % "	1.017	4.92
Cl	1.014	5.67	0.25 % "	1.027	5.49	1 % "	1.038	4.20
Cl	1.0004	5.63	0.50 % "	1.056	5.20	2 % "	1.075	3.05
	1.0091	5.17	1 % "	1.116	4.75	3 % "	1.112	2.24
	1.021	4.59	2 % "	1.23	3.77	4 % "	1.149	1.62
	1.044	3.63	5 % "	1.46	1.81	0.125% $\text{Na}_2\text{SO}_4$	1.014	5.04
	1.113	1.97	0.25 % $\text{KNO}_3$	1.015	5.49	0.25 % "	1.032	4.60
	1.220	1.12	0.50 % "	1.029	5.11	0.50 % "	1.063	3.97
Cl	1.011	5.35	1 % "	1.059	4.61	1 % "	1.130	3
	1.044	4.37	2 % "	1.110	3.65	0.125% Sucrose	1.015	5.40
	1.085	3.18	0.125% $\text{K}_2\text{SO}_4$	1.016	5.11	0.25 % "	1.033	4.82
	1.160	2.22	0.25 % "	1.032	4.66	0.50 % "	1.065	4.39
	1.284	0.78	0.5 % "	1.060	3.89	1 % "	1.147	3.20
	1.343	0.54	0.125% RbCl	1.0094	5.65	2 % "	1.336	1.84



## SOLUBILITY OF OXYGEN IN AQUEOUS SULFURIC ACID SOLUTIONS.

Results at 21°. (Bohr, 1910.)				Results at 20°. (Christoff, 1908.)	
Normality of $H_2SO_4$ .	Absorp. Coef. $\beta$ .	Normality of $H_2SO_4$ .	Absorp. Coef. $\beta$ .	Wt. % $H_2SO_4$ .	Ostwald Solubility Expression $l_0$ .
0	0.0310	24.8	0.0103	0	0.03756
4.9	0.0195	29.6	0.0117	35.82	0.01815
8.9	0.0155	34.3	0.0201	61.62	0.01407
10.7	0.0143	35.8 (=96%)	0.0275	95.60	0.03303
20.3	0.0119				

## SOLUBILITY OF OXYGEN IN ETHYL ALCOHOL, METHYL ALCOHOL AND IN ACETONE.

(Timofejew — Z. physik. Ch. 6, 151, '90; Levi — Gazz. chim. ital. 32, II, 513, '01)

t°.	In Ethyl Alcohol of 90.7% (T.).		In Methyl Alcohol (L.)	In Acetone (L.)
	$\beta$ .	$\beta'$ .		
0	0.2337	0.2297	0.31864	0.2997
5	0.2301	0.2247	0.30506	0.2835
10	0.2266	0.2194	0.29005	0.2667
15	0.2232	0.2137	0.27361	0.2493
20	0.2201	0.2073	0.25574	0.2313
25	0.2177 (24°)	0.2017 (24°)	0.23642	0.2127
30	...	...	0.21569	0.1935
40	...	...	0.16990	0.1533
50	...	...	0.11840	0.1057

For values of  $\beta$  and  $\beta'$ , see Ethane, p. 285.  $l$  = Ostwald Solubility Expression. See p. 227.

The formulæ expressing the solubility of oxygen in methyl alcohol and in acetone as shown in the above table are as follows:

In Methyl Alcohol  $l = 0.31864 - 0.002572 t - 0.00002866 t^2$ .

In Acetone  $l = 0.2997 - 0.00318 t - 0.000012 t^2$ .

The formula expressing the absorption coefficient of oxygen in ethyl alcohol is  $\beta = 0.23370 - 0.00074688 t + 0.000003288 t^2$ .

## SOLUBILITY OF OXYGEN IN AQUEOUS ALCOHOL AT 20° AND 760 MM.

(Lubarsch, 1889)

Wt. Per cent Alcohol.	Vol. Per cent Absorbed O.	Wt. Per cent Alcohol.	Vol. Per cent Absorbed O.	Wt. Per cent Alcohol.	Vol. Per cent Absorbed O.
0	2.98	23.08	2.52	50	3.50
9.09	2.78	28.57	2.49	66.67	4.91
16.67	2.63	33.33	2.67	80	5.60

## SOLUBILITY OF OXYGEN IN PETROLEUM. COEFFICIENT OF ABSORPTION

10° = 0.229, AT 20° = 0.202.

(Gniewasz and Walfisz, 1887.)

## SOLUBILITY OF OXYGEN ETHYL ETHER.

(Christoff, 1912.)

Results in terms of the Ostwald Solubility Expression,  $l_0 = 0.4235$ ,  $l_1 = 0.4215$ .



## SOLUBILITY OF OXYGEN IN AQUEOUS SOLUTIONS OF:

Glycerol at 20°. (Müller, 1912-13.)

Glycerol at 15°. (Müller, 1912-13.)

$d_{20}^0$ of Aq. Sol.	Abs. Coef. $\beta$ (Bunsen) at 20°.	Gms. $(\text{CH}_2\text{OH})_2\text{CHOH}$ per 100 Gms. Aq. Sol.	$d$ of Aq. Sol.	Abs. Coef. $\beta$ (Bunsen) at 15°.
1.0798	0.02795	20.5	$d_{12.5} = 1.0509$	0.02742
1.1630	0.02495	25	$d_{13} = 1.0621$	0.02521
1.2935	0.02325	37.3	$d_{14.5} = 1.0957$	0.02022
1.354	0.02410	45	$d_{15.5} = 1.1161$	0.01744
1.382	0.02580	52	$d_{12.5} = 1.1351$	0.01570
1.4404	0.02730	71.5	$d_{12.5} = 1.1908$	0.00950
1.46	0.03280	88.5	$d_{12.5} = 1.236$	0.00886

## SOLUBILITY OF OXYGEN IN AQUEOUS SOLUTIONS OF:

Cane Sugar at 20°. (Müller, 1912-13.)

Cane Sugar at 15°. (Müller, 1912-13.)

$d_{20}^0$ of Aq. Sol.	Abs. Coef. $\beta$ (Bunsen) at 20°.	Gms. $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ per 100 Gms. Aq. Sol.	$d_{15}^0$ of Aq. Sol.	Abs. Coef. $\beta$ (Bunsen) at 15°.
1.0413	0.02690	12.1	1.0482	0.02969
1.0835	0.02250	24.38	1.1022	0.02396
1.1370	0.01815	28.44	1.1205	0.02181
1.2295	0.01390	42.96	1.1938	0.01600
1.2649	0.01250	50	1.2318	0.01359

OF ANESTHETICS UPON THE SOLUBILITY OF OXYGEN IN OLIVE OIL.  
(Hamberger, 1911.)

Conc. of Added Oil.	Solubility of Oxygen in:		Name and Conc. of Narcotic Added to the Oil.	Solubility of Oxygen in:	
	Pure Solvent.	Narcotic Solution.		Pure Solvent.	Narcotic Solution.
0.8 per 100)	9.69	4.55	Monochlorhydrine (5 per 100)	9.10	7.50
	9.69	5.68	" (2.5 " )	9.10	7.50
	9.69	6.25	" (1.25 " )	9.10	7.90
saturated)	9.10	4.55	Dichlorhydrine (10 " )	9.10	7.96
	9.10	5.68	" (5 " )	9.10	8
2 per 100)	9.67	9.10	Phenylurethan (5 " )	8.53	6.25
	9.67	9.20	" (2.5 " )	8.53	7.50
10 per 100)	8.53	7.96			

the solubility of oxygen in liquid air are given by Baly (1900).

the solubility of oxygen in hemoglobin are given by Jolin (1889).

the solubility of oxygen in defibrinated ox-blood and ox-serum, at varying from 760 to about 1400 mm. Hg, are given by Findlay and (1911).

2.

## SOLUBILITY IN WATER.

(von Mailfert, 1894; Carius; Schöne, 1873.)

W.	G.	R.	t°.	W.	G.	R.
39.4	61.5	0.641	27	13.9	51.4	0.270
34.3	61	0.562	33	7.7	39.5	0.195
29.9	59.6	0.500	40	4.2	37.6	0.112
28	58.1	0.482	47	2.4	31.2	0.077
25.9	56.8	0.456	55	0.6	19.3	0.031
21	55.2	0.381	60	0	12.3	0

ligrams ozone dissolved per liter water.  $G$  = milligrams ozone in the gas phase above the solutions.  $R$  = ratio of the dissolved to 1 ozone ( $W + G$ ).



The experiments of Schöne (see preceding page) were repeated by Inglin (1903). "The results confirm Schöne's experiments and indicate that ozone, when passed through water, is partly decomposed."

According to Moufang (1911) the solubility of ozone in distilled water ranges from about 10 milligrams per liter at 2° to about 1.5 milligrams per liter at 26°. The solubility is greatly affected by other substances in solution. Small amounts of acids increase the solubility and render the aqueous solution of the ozone more permanent. Alkalis decrease the solubility. Neutral salts (i.e., calcium sulfate) increase the solubility.

#### SOLUBILITY OF OZONE IN DILUTE SULFURIC ACID.

(Rothmund, 1912.)

The explanation of the discrepancies concerning the solubility of ozone in water is that the ozone quickly decomposes as the saturation point is reached. Rothmund, therefore, determined the solubility in dilute  $H_2SO_4$  in which decomposition takes place much more slowly than in pure water. At 0° the absorption coef.  $\beta$  (Bunsen, see p. 227) in 0.1 N  $H_2SO_4$  is 0.487. The coef. remains practically the same when the concentration of the ozone is changed over a wide range, hence Henry's Law holds for ozone. The dissolved ozone has the same molecular weight as the gaseous. The solubility depression which ozone experiences through 0.1 N  $H_2SO_4$  is calculated as 1.5%. Therefore, by extrapolation, it is calculated that the abs. coef.  $\beta$  of ozone in  $H_2O$  at 0°, is 0.494.

#### PALLADIUM CHLORIDE $PdCl_2$ .

When 1 gm. of palladium, as chloride, is dissolved in 100 cc. of  $H_2O$  and shaken with 100 cc. of ether, 0.02 per cent of the metal enters the ethereal layer at ord. temp. When aq. 10%  $HCl$  is used, 0.01 per cent of the metal enters the ethereal layer. (Mylius, 1911.)

100 cc. anhydrous hydrazine dissolve 1 gm.  $PdCl_2$ , with evolution of gas and formation of a black precipitate, at room temperature. (Welsh and Broderson, 1914.)

#### PALMITIC ACID $CH_3(CH_2)_{14}COOH$ .

##### SOLUBILITY IN AQ. AND ABSOLUTE ETHYL ALCOHOL.

(Falcicola, 1910.)

t°.	Gms. $CH_3(CH_2)_{14}COOH$ per 100 cc.:		
	Absolute Alcohol.	Aq. 75% Alcohol.	Aq. 50% Alcohol.
10	2.8	0.24	0.05
20	9.2	0.43	0.08
30	...	1.19	0.12
40	31.9	3.59	0.31

100 cc. sat. solution of palmitic acid in methyl alcohol of 94.4 vol. % ( $d = 0.8183$ ) contain 1.03 to 1.17 gms. at 0.2°, equilibrium being approached from above. The mixtures were simply allowed to stand in an ice chest for from 12 to 156 hours. (Hegner and Mitchell, 1897.)

##### SOLUBILITY OF PALMITIC ACID IN SEVERAL ALCOHOLS.

(Timofeiew, 1894.)

Alcohol.	t°.	Gms. $CH_3(CH_2)_{14}COOH$ per 100 Gms. Sat. Sol.	Alcohol.	t°.	Gms. $CH_3(CH_2)_{14}COOH$ per 100 Gms. Sat. Sol.
Methyl Alcohol	0	0.72	Propyl Alcohol	0	2.02
"	21	5.1	"	21	13.8
"	36	29.5	Isobutyl Alcohol	0	2.2
Ethyl Alcohol	0	2	"	21	12.8
"	21	10.1			

One hundred gms. of aq. 5% solution of bile salts dissolve about 0.1 gm. palmitic acid. 100 gms. aq. 5% solution of bile salts containing 1% of lecithin dissolve 0.6 gms. palmitic acid. (Moore, Wilson and Hutchinson, 1909.)



## MELTING POINTS OF MIXTURES OF PALMITIC AND STEARIC ACIDS.

(De Visser, 1898.)

Samples of each mixture were used and great care taken to insure accurate determinations.

Gms. Stearic Acid per 100 Gms. Mixture.	t° of Solidi- fication.	Gms. Stearic Acid per 100 Gms. Mixture.	t° of Solidi- fication.	Gms. Stearic Acid per 100 Gms. Mixture.
100	57.2	55	54.85	Eutec. 30
90	56.42	50	55.46	25
80	56.38	45	56.53	20
70	56.11	40	59.31	10
60	55.62	36	62.62	0

Determinations on this system by Dubowitz (1911) are, for the good agreement with the above. According to Carlinfanti and (1909), however, the eutectic could not be located and there were no solid solutions.

## GIVEN FOR THE SOLIDIFICATION POINTS OF THE FOLLOWING

Stearic Acid + Tripalmitin	(Kremann and Klein, 1913.)
+ " + Stearic Acid.	" "
+ " + Tristearin.	(Kremann and Kropsch, 1914.)
+ Tristearin + Stearic Acid.	" "
+ Tristearin.	" "
+ Tristearin + Stearic Acid.	" "
+ Stearic Acid.	(Kremann and Klein, 1913.)
Stearic Acid + Cetyl Ester + Paraffin.	(Palazzo and Battelli, 1883.)

I.  $C_{20}H_{42}NO_4$ .

bon tetrachloride dissolve 0.203 gm. at 17°. (Schindelmeiser, 1901.)

bon tetrachloride dissolve 0.518 gm. at 20°. (Gori, 1913.)

yl ether dissolve 0.38 gm. at 10°.

Each of the following solvents dissolve the stated amount of papaverine, 29 gms.; pyridine, 8 gms.; piperidine, 1 gm.; diethylamine, (Scholtz, 1912.)

## OF OZOKERITE PARAFFIN OF MELTING POINT 64°-65° AND

Gr. at 20° = 0.917 IN SEVERAL SOLVENTS AT 20°.

(Pawlewski and Filemonowicz, 1888.)

Temperat.	Gms. Paraffin per 100		Solvent.	Gms. Paraffin per 100	
	Gms. Solvent.	cc. Solvent.		Gms. Solvent.	cc. Solvent.
below 75°	12.99	...	Acetone	0.262	0.209
pt. 158°-166°	11.73	8.48	Ethyl Acetate	0.238	...
pt. 160°	6.06	5.21	" Alcohol	0.219	...
pt. 160°	4.26	3.72	Amyl Alcohol	0.202	0.164
pt. 135°-143°	3.99	3.39	Propionic Acid	0.165	...
pt. 138°	3.95	3.43	Propyl Alcohol	0.141	...
pt. 108°-110°	4.39	3.77	Methyl Alcohol	0.071	0.056
pt. 108°-109°	3.88	3.34	Methyl Formate	0.060	...
	3.92	3.41	Acetic Acid	0.060	0.063
	2.42	3.61	" Anhydride	0.025	...
	1.99	1.75	Formic Acid	0.013	0.015
	1.95	...	Ethyl Alcohol 75%	0.0003	...
com.	0.285	0.228			

Paraffin + stearin are given by Palazzo and Battelli (1883).



# PENTANE

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## PENTANE $\text{CH}_3(\text{CH}_2)_3\text{CH}_3$ .

Data for the solubility of pentane in liquid carbon dioxide, determined by the synthetic method, are given by Büchner (1906).

## ISO-PENTANE $(\text{CH}_3)_2\text{CH}.\text{CH}_2\text{CH}_3$ .

RECIPROCAL SOLUBILITY OF ISOPENTANE AND PHENOL. (Campetti and Del Grosso, 1911.)

t°.	Gms. Phenol per 100 Gms.	
	Isopentane Rich Layer.	Phenol Rich Layer.
20	4.5	87
30	7	83.5
40	11.5	80
50	18	75.5
60	29.5	68
65	40	58
66 crit. temp.	50	

F.-pt. data for mixtures of hexachloro- $\alpha$ -keto  $\gamma$ -R-pentene,  $\text{C}_6\text{Cl}_6\text{O}$ , + penta chloromonobromo  $\alpha$ -keto  $\gamma$ -R pentene,  $\text{C}_6\text{Cl}_5\text{BrO}$ , are given by Küster (1890, 1891).

## PEPTONE.

100 gms. $\text{H}_2\text{O}$	dissolve 42.2 gms. peptone at 20–25°.	(Dehn, 1917)
" pyridine	" 0.22 "	" "
" aq. 50% pyridine	" 12.6 "	" "

## PERCHLORIC ACID $\text{HClO}_4$ .

SOLUBILITY IN WATER. (van Wyk, 1902, 1905.)

Mixtures of  $\text{HClO}_4$  and water were cooled until crystals appeared and then very gradually warmed and constantly stirred while an observation was made of the exact temperature at which the last crystal disappeared. At certain concentrations and temperatures unstable solid phases were obtained, also, curves for two series of mix crystals were encountered. The methods for detecting these phases consisted in seeding the saturated solutions with the several different crystalline forms, and observing the change in rate of cooling during the solidification of the mixture. The data for the mix-crystal curves I and II are not given in the following table:

t°.	Mols. $\text{HClO}_4$ per 100 Mols. $\text{HClO}_4 + \text{H}_2\text{O}$ .	Solid Phase.	t°.	Mols. $\text{HClO}_4$ per 100 Mols. $\text{HClO}_4 + \text{H}_2\text{O}$ .	Solid Phase.
0	0	Ice	–32	26	$\text{HClO}_4 \cdot 1\frac{1}{2}\text{H}_2\text{O}$
–10	5	"	–29.8	28.57	"
–21	7	"	–44	27	$\text{HClO}_4 \cdot 2\text{H}_2\text{O}$
–34.5	9	"	–41	27.25	"
–54	11	"	–34	28	"
–50.5	19	$\text{HClO}_4 \cdot 3\frac{1}{2}\text{H}_2\text{O}$	–24	29.9	"
–45	20	"	–17.8 m. pt.	33.3	"
–42.3	21	"	–21.5	36	"
–41.4	22.22	"	–23.6	36.5	" + $\text{HClO}_4 \cdot \text{H}_2\text{O}$
–43	23.5	"	–12.5	37	$\text{HClO}_4 \cdot \text{H}_2\text{O}$
–40.5	22.5	$\text{HClO}_4 \cdot 3\text{H}_2\text{O} \alpha$	+3	38	"
–39.5	22.75	"	28	40.8	"
–37.6	24	"	40	43.7	"
–37.5	26	"	50 m. pt.	50	"
–38.8	27	"	45	59.9	"
–47.8	22.5	$\text{HClO}_4 \cdot 3\text{H}_2\text{O} \beta$	27.5	71.5	"
–44	24	"	17	77.2	"
–43.5	24.5	"	+2.2	83.3	"
–43.2	25	"	–21.5	90.7	"
–44.5	26	"	–40	94	"
–37.2	25	$\text{HClO}_4 \cdot 3\text{H}_2\text{O} \alpha + \text{HClO}_4 \cdot 2\text{H}_2\text{O}$	–102	100	"



**UM ETHER.**

$\text{H}_2\text{O}$  dissolve 0.005 cc. petroleum ether at  $15^\circ$ . (Groschuff, 1910.)

**TIN** (*p* Acetphenetidin)  $\text{C}_6\text{H}_4(\text{OC}_2\text{H}_5)\text{NHCH}_3\text{CO } p$ .

SOLUBILITY IN AQUEOUS ALCOHOL AT  $25^\circ$ .

(Seidell, unpublished.)

H	$d_4$ of Sat. Sol.	Gms. $\text{C}_6\text{H}_4(\text{OC}_2\text{H}_5)$ $\text{NHCH}_3\text{CO}$ per 100 Gms. Sat. Solution.	Wt. % $\text{C}_2\text{H}_5\text{OH}$ in Solvent.	$d_4$ of Sat. Sol.	Gms. $\text{C}_6\text{H}_4(\text{OC}_2\text{H}_5)$ $\text{NHCH}_3\text{CO}$ per 100 Gms. Sat. Solution.
) I		0.0766	70	0.879	6.25
	0.984	0.14	80	0.858	7.63
	0.968	0.28	85	0.847	7.88
	0.952	0.65	90	0.834	7.82
	0.935	1.50	92.3	0.827	7.70
	0.917	2.85	95	0.821	7.45
	0.898	4.55	100	0.806	6.64

$\text{H}_2\text{O}$  dissolve 1.43 gms. phenacetin at the b. pt. (U. S. P., VIII.)

2.3 wt. % alcohol dissolve about 50 gms. phenacetin at the b. pt. "

**SOLUBILITY OF PHENACETIN IN SEVERAL SOLVENTS.**

(Seidell, 1907.)

mt.	$t^\circ$ .	Gms. Phenacetin per 100 Gms. Sat. Solution.	Solvent.	$t^\circ$ .	Gms. Phenacetin per 100 Gms. Sat. Solution.
	30-31	10.68	Benzene	30-31	0.65 (0.873)
ate	30-31	2.42 (0.865)	Chloroform	25	4.76
hol	25	3.51 (0.819)	Ether	25	1.56
l (99.5%)	21.5	13.65 (1.064)	Toluene	25	0.30 (0.863)
	30-31	9.46 (1.025)	Xylene	32.5	1.25 (0.847)
nde	30-31	8.44 (1.063)			

(Figures in parentheses are Sp. Gr. of Sat. Solutions.)

roleum ether dissolve 0.015 gm. phenacetin at room temp. (Salkower, 1916.)

pyridine dissolve 17.39 gms. phenacetin at  $20-25^\circ$ . (Dehn, 1917.)

iq. 50% pyridine dissolve 28.94 gms. phenacetin at  $20-25^\circ$ . "

**ANTHRAQUINONE**  $\text{C}_{14}\text{H}_8\text{O}_2$ 

SOLUBILITY IN BENZENE AND IN ETHYL ACETATE.

(Tyrer, 1910.)

Solubility in Benzene.			Solubility in Ethyl Acetate.		
Gr. of Solution.	Gms. $(\text{C}_6\text{H}_5)_2(\text{CO})_2$ per 100 Gms. Benzene.	$t^\circ$ .	Sp. Gr. of Sat. Solution.	Gms. $(\text{C}_6\text{H}_5)_2(\text{CO})_2$ per 100 Gms. Ethyl Acetate.	
.8902	0.412	10	0.9102	0.518	
.8850	0.471	20	0.9025	0.626	
.8800	0.538	30	0.8906	0.770	
.8698	0.738	40	0.8789	0.995	
.8601	1.032	50	0.8674	1.292	
.8506	1.354	60	0.8561	1.640	
.8415	1.760	65	0.8508	1.902	
.8327	2.687	70	0.8454	2.215	
.8241	3.770	75	0.8401	2.515	

The Sp. Gr. determinations given in the above table and in the tables for anthraquinone, pp. 81 and 82, are not included in the original paper (1910) but, in response to my request, have been kindly supplied by Dr. Tyrer. I am also indebted to Dr. Tyrer for the modified formulae and tables showing the solubilities of anthraquinone and phenanthraquinone in various solvents. (A. S.)



SOLUBILITY OF PHENANTHRAQUINONE IN MIXTURES OF ORGANIC SOLVENTS.  
(Tyrer, 1910.)

In $C_6H_6$ + Hydrocarbons (1) at 48°.		In $CHCl_3$ + Pentane at 14.5°.		In $CH_3COOC_2H_5$ + Hydrocarbons(1) at 48°.	
Per cent $C_6H_6$ in Mixed Solvent	Gms. Phenanthraquinone per 100 Gms. Solvent.	Per cent $CHCl_3$ in Mixed Solvent.	Gms. Phenanthraquinone per 100 Gms. Solvent.	Per cent $CH_3COOC_2H_5$ in Mixed Solvent.	Gms. Phenanthraquinone per 100 Gms. Solvent.
0	0.0708	0	0.025	0	0.073
10	0.088	10	0.045	14.19	0.126
20	0.118	20	0.080	27.37	0.207
30	0.160	30	0.115	39.94	0.335
40	0.228	40	0.165	52.12	0.494
50	0.318	50	0.220	63.56	0.656
60	0.440	60	0.330	74.19	0.817
70	0.588	70	0.525	84.62	0.993
80	0.772	80	0.805	90	1.073
90	1.004	90	1.415	100	1.230
100	1.288	100	2.402		

(1) Distilled from petroleum, b. pt. = 81°-91°. (See note, preceding page.)

PHENANTHRENE  $C_{14}H_{10}$ .

SOLUBILITY IN ALCOHOL AND IN TOLUENE.\*

(Speyers — Am. J. Sci. [4] 14, 295, '02.)

In Alcohol.			In Toluene.		
t°.	Gms. $C_{14}H_{10}$ per 100 Grams $C_2H_5OH$ .	Sp. Gr. of Solutions ( $H_2O$ at 4°.)	Gms. $C_{14}H_{10}$ per 100 Grams $C_6H_5CH_3$	Sp. Gr. of Solutions ( $H_2O$ at 4°.)	
0	3.65	0.814	23.0	0.925	
10	3.80	0.807	30.0	0.929	
20	4.6	0.801	42.0	0.934	
25	5.5	0.799	50.0	0.939	
30	6.4	0.797	58.0	0.943	
40	8.2	0.795	76.0	0.955	
50	10.6	0.794	95.0	0.971	
60	15.6	0.797	115.0	0.989	
70	33.0	0.815	135.0	1.007	
80	...	0.865 (76.4°)	155.0	1.027	

\* Calculated from the original results which are given in terms of gram molecules of Phenanthrene per 100 gram molecules of solvent, and for irregular intervals of temperature.

Behrend, 1892, reports 2.77 gms. phenanthrene per 100 gms. alcohol at 12.3°, and 3.09 gms. at 14.8°.

SOLUBILITY OF PHENANTHRENE IN ORGANIC ACIDS. (Timofeiew, 1892.)

Acid.	t°.	Gms. $C_{14}H_{10}$ per 100 Gms. Sat. Sol.	Acid. ]	t°.	Gms. $C_{14}H_{10}$ per 100 Gms. Sat. Sol.
Acetic Acid	23	8.31	Propionic Acid	23	1.1
" "	39	9.8	" "	39	2.1 - 4
" "	70.5	34.6	" "	62.4	4.0 - 3
Butyric Acid	23	15.6	Isobutyric Acid	23	1.2 - 3
" "	39	21	Valeric Acid	39	1.6 - 6

100 gms. 95% formic acid dissolve 0.46 gms.  $C_{14}H_{10}$  at 20.8°. (Ascham, 1894.)

F.-pt. data for mixtures of phenanthrene and each of the following compounds are given by Kremann *et al.*, (1908); 1.2.6 dinitrotoluene, 1.2.4. dinitrotoluene, 1.3.4 dinitrotoluene, trinitrotoluene and trinitrobenzene. Results for mixtures of phenanthrene and 2.4 dinitrotoluene are given by Kremann and Holmeier (1910).



**SOLUBILITY OF PHENANTHRENE IN SEVERAL SOLVENTS AT 25°.**  
(Hildebrand, Ellefson and Beebe, 1917.)

Solvent.	Gms. $C_{14}H_{10}$ per 100 Gms. Solvent.	Solvent.	Gms. $C_{14}H_{10}$ per 100 Gms. Solvent.
ol	4.91	Carbon Tetrachloride	26.3
ne	59.5	Ether	42.9
on Disulfide	80.3	Hexane	9.15

**SOLUBILITY OF PHENANTHRENE PICRATE IN ABSOLUTE ALCOHOL.**  
(Behrend, 1892.)

t°.	Grams per 100 Grams Saturated Solution.		
	Picric Acid	+ Phenanthrene	= Phenanthrene Picrate.
12.3	0.91	0.71	1.62
14.3	1.00	0.78	1.78
17.5	1.05	0.82	1.87

**SOLUBILITY OF PHENANTHRENE PICRATE IN ALCOHOLIC SOLUTIONS CONTAINING PICRIC ACID AND ALSO PHENANTHRENE.**  
(Behrend.)

Grams Added to 62 cc. Abs. Alcohol.				Gms. per 100 Gms. Sat. Solution.		
P. Picrate + Picric Ac. + Phenanthrene.				Picric Ac. + Phenanthrene = P. Picrate.		
3	1.4	0	0.5	0.534	1.413	1.947
3	1.4	0	0.9	0.409	2.141	2.550
3	0.8	0	2.1	0.354	2.77	3.124
3	0.8	0	4.0	0.139	5.626	5.765
.5	1.4	0.1	0	1.159	0.75	1.91
.5	1.4	0.2	0	1.285	0.68	1.97
.5	1.4	1.0	0	2.45	0.37	2.82
.5	1.4	4.0	0	6.15	0.195	6.345
.5	1.4	0.0	2.2	0.423	3.276	3.699

**SOL.  $C_6H_5OH$ .**

**SOLUBILITY IN WATER.**  
(Alexejew, 1886; Schreinemaker, 1900; Rothmund, 1898.)

determinations were made by the "Synthetic Method," for which, see p. 16.

t°.	Gms. Phenol per 100 Gms.	
	Aqueous Layer.	Phenol Layer.
10	7.5	75
20	8.3	72.1
30	8.8	69.8
40	9.6	66.9
50	12	62.7
55	14.1	59.5
60	16.7	55.4
65	21.9	49.2
68.3 (crit. temp.)	33.4	

data confirming the above, and also viscosity measurements, are given by (1904).

complete  $T - x$  data for the system are given by Smits and Maarse (1911).

t. data for the system are given by Rózsa (1911) and Paterno and Ampola

bel (1895) states that 100 gms. sat. aqueous solution contain 6.1 gms. at 20°. Sp. Gr. of solution = 1.0057.



PHENOL.

SOLUBILITY OF PHENOL IN AQUEOUS ACETONE SOLUTIONS.  
(Schreinemakers, 1900.)

t°.	In 4.24% Acetone.		In 12.2% Acetone.		In 24.6% Acetone.		In 59.9% Acetone.	
	Gms. Phenol per 100 Gms.		Gms. Phenol per 100 Gms.		Gms. Phenol per 100 Gms.		Gms. Phenol per 100 Gms.	
	Aq. Acetone Layer.	Phenol Layer.	Aq. Acetone Layer.	Phenol Layer.	Aq. Acetone Layer.	Phenol Layer.	Aq. Acetone Layer.	Phenol Layer.
20	...	...	...	...	...	...	26.0	60.5
30	5.0	74.0	4.0	71.0	6.0	69.5	28.5	57.0
40	5.5	70.0	...	...	...	...	32.0	52.0
50	5.7	67.0	5.0	67.0	8.0	64.0	34.5§	49.0§
60	6.5	61.0	...	...	...	...	36.5	46.5
70	9.0	51.0	7.5	57.5	19.0	57.0	(49.5 <sup>b</sup> )	41.5
80	14.0	34.0	10.5	49.5	14.0	52.5		
	(84°) 22.5		20.4*	30.5*	23.0†	47.0†		
			(90.3°) 25.0		26.5‡	44.0‡		
					(90.5°) 35.0			
	90°		185°		187°-5	545°	147°-5	

The figures in the above table were read from curves plotted from the original results. Similar data are also given for acetone solutions of seven other concentrations.

The determinations were made by adding various quantities of phenol to the mixtures of water and acetone and observing the temperature at which the two layers became homogeneous. The isothermal lines for 30°, 50°, 68°, 80°, 85° and 87° were located. The results for 30° and 80° are as follows: (Schreinemakers, 1900.)

Results at 30°.						Results at 80°.					
Gms. per 100 Gms. Mixture.			Gms. per 100 Gms. Mixture.			Gms. per 100 Gms. Mixture.			Gms. per 100 Gms. Mixture.		
H <sub>2</sub> O.	(CH <sub>3</sub> ) <sub>2</sub> CO.	C <sub>6</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	(CH <sub>3</sub> ) <sub>2</sub> CO.	C <sub>6</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	(CH <sub>3</sub> ) <sub>2</sub> CO.	C <sub>6</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	(CH <sub>3</sub> ) <sub>2</sub> CO.	C <sub>6</sub> H <sub>5</sub> OH.
92	0	8	18.4	34.1	47.5	83.3	3.7	13			
92.3	1.7	6	17.2	25.8	57	82.9	7.1	10			
91	4	5	17.9	81.1	64	74.7	13.8	11.5			
88.4	7.6	4	19.1	12.9	68	61.8	20.2	18			
81	15	4	21.1	9.9	69	52.5	24.5	23			
70.9	23.1	6	22.6	7.4	70	40.6	27.4	32			
62.1	28.9	9	25.2	4.6	70.2	32.2	21.8	40			
51.6	34.9	13.5	27.1	2.3	70.6	33.4	15.6	51			
39.8	40.2	20	28.7	1.3	70	35.4	11.6	53			
28.9	43.1	28	30	0.5	69.5	40.5	7.5	52			
21.8	40.2	38				49.7	4.3	46			
						62.7	2.8	34.5			

SOLUBILITY OF PHENOL IN BENZENE AND IN PARAFFIN.  
(Schweissinger, 1884-85.)

Solvent.	Gms. C <sub>6</sub> H <sub>5</sub> OH per 100 Gms. Solvent at:			
	16°.	21°.	25°.	43°.
Paraffin	1.66	...	...	5
Benzene	2.5	8.33	10	100

Data for equilibrium in systems composed of phenol, water and each of the following compounds are given by Timmermans (1907): NaCl, KCl, KBr, KNO<sub>3</sub>, K<sub>2</sub>SO<sub>4</sub>, MgSO<sub>4</sub>, tartaric acid, salicylic acid, succinic acid and sodium oleate.



# SOLUBILITY OF AQUEOUS ALKALINE SOLUTIONS OF PHENOL WITH SEVERAL ORGANIC COMPOUNDS INSOLUBLE IN WATER.

(Scheuble, 1907.)

c. portions of aq. KOH solution (250 gms. per liter) were added the given of the aq. insoluble compound from a buret and then the phenol, drop-til solution occurred. Temperature not stated.

## Composition of Homogeneous Solutions.

cc. Aq. KOH.	cc. Aq. Insol. Cmpd.	Gms. Phenol.
5	2 (= 1.64 gms.) Octyl * Alcohol	2.6
5	5 (= 4.1 gms.) " "	3.9
5	2 (= 1.74 gms.) Toluene	4.9
5	3 (= 2.61 gms.) Toluene	6.7
5	2 (= 1.36 gms.) Heptane	15

normal secondary octyl alcohol, i. e., the so-called capryl alcohol,  $\text{CH}_3(\text{CH}_2)_7\text{CH}(\text{OH})\text{CH}_3$ .

# SOLUBILITY OF PHENOL IN AQUEOUS SOLUTIONS OF DEXTRO TARTARIC ACID AND OF RACEMIC ACID.

(Schreinemakers, 1900.)

5.093% Acid.		In 19.34% Acid.		In 40.9% Acid.	
Gms. Phenol per 100 Gms.		Gms. Phenol per 100 Gms.		Gms. Phenol per 100 Gms.	
Aq. Acid Layer.	Phenol Layer.	°.	Aq. Acid Layer. Phenol Layer.	°.	Aq. Acid Layer. Phenol Layer.
7.5	72.5	50	10 77	70	13 ...
10.5	65.5	60	12.5 72	80	16.5 77
14.5	58	70	19 64	85	20 74
19.5	53	75	29 56	90	26.5 71
25	48.5	77*	47	95	39 63.5
47.5				97*	54

\* Critical temperature.

ical results were obtained with the dextro and racemic acids, showing that ve exactly the same influence on the formation of layers in the system henol.

## DISTRIBUTION OF PHENOL BETWEEN:

### ALCOHOL AND WATER AT 25°. BENZENE AND WATER AT 20°.

rz and Fischer — Ber. 37, 4747, '04.)

(Vaubel — J. pr. Ch. [2] 67, 476, '03.)

Gm. Phenol per 100 cc.	Gms. Phenol per 100 cc.		Volumes of Solvents used per 1 Gm. Phenol	Gms. Phenol in		
	Alcoholic Layer.	Aqueous Layer.		H <sub>2</sub> O Layer.	C <sub>6</sub> H <sub>6</sub> Layer	
5	0.047	0.705	0.0441	50 cc. H <sub>2</sub> O +	50 cc. C <sub>6</sub> H <sub>6</sub>	0.286 0.714
	0.05	0.846	0.047	" + 100 cc. "	"	0.1188 0.8212
	0.07	1.035	0.066	" + 150 cc. "	"	0.0893 0.9107
	0.16	2.445	0.150	" + 200 cc. "	"	0.0893 0.9107
	3.83	50.88	3.601			
	3.9	52.93	3.667			

# DISTRIBUTION OF PHENOL BETWEEN WATER AND BENZENE AT 20°.

(Philip and Bramley, 1915.)

Gms. Phenol per Liter.		Ratio $\frac{b}{a}$ .	Gms. Phenol per Liter.		Ratio $\frac{b}{a}$ .
ayer, a.	C <sub>6</sub> H <sub>6</sub> Layer, b.		Aq. Layer, a.	C <sub>6</sub> H <sub>6</sub> Layer, b.	
145	2.073	2.194	0.356	0.7736	2.173
188	1.944	2.189	0.238	0.5177	2.175
111	1.553	2.184	0.119	0.2594	2.180
194	1.293	2.176	0.0601	0.1314	2.189
175	1.036	2.181			

Its are also given for the effect of NaCl, KCl and of LiCl upon the above ation.



DISTRIBUTION OF PHENOL BETWEEN WATER AND BENZENE  
BETWEEN AQUEOUS  $K_2SO_4$  SOLUTIONS AND BENZENE AT 25°  
(Rothmund and Wilsmore — Z. physik. Ch. 40, 623, '02.)

NOTE. — The original results, which are given in terms of g mols. per liter, were calculated to grams per liter, and plotted on a section paper. The following figures were read from the curves obtained.

Between $H_2O$ and $C_6H_6$ .		Effect of $K_2SO_4$ upon the Distribution.					
Grams $C_6H_5OH$ per Liter of:		Gms. $K_2SO_4$ per Liter	(1) Gms. $C_6H_5OH$ per Liter of:		(2) Gms. $C_6H_5OH$ per Liter of:		
$H_2O$ Layer.	$C_6H_6$ Layer.	Aq. Solution.	Aq. Layer.	$C_6H_6$ Layer.	Aq. Layer.	$C_6H_6$ Layer.	$C_6H_5OH$ in $C_6H_6$ Layer.
5	10	1.36	17.08	59.96	9.52	26	— 28
10	28	2.72	16.92	60.63	9.50	26	— 38
15	52	5.44	16.85	60.92	9.46	26	— 55
20	84	10.89	16.44	62.73	9.35	27	— 66
25	128	21.79	15.89	65.19	9.09	28	— 27
30	200	43.59	14.85	69.71	8.68	30	— 21
35	300	87.18	12.92	78.00	7.79	34	— 38
40	410						
45	520						
50	610						

(1) First series.

(2) Second series.

EQUILIBRIUM IN THE SYSTEM PHENOL, BENZENE AND WATER AT 25°  
(Horiba, 1914-1916.)

Gms. per 100 Gms. Sat. Sol.			Solid Phase.
$C_6H_5OH$ .	$C_6H_6$ .	$H_2O$ .	
81.06	18.94	0	$C_6H_5OH$
89.78	7.92	2.30	"
92.31	4.07	3.62	"
95.14	0	4.86	"

The results for the conjugated liquid layers are as follows:

Upper Layer.			Lower Layer.		
Gms. per 100 Gms. of the Liquid.			Gms. per 100 Gms. of the Liquid.		
$C_6H_5OH$ .	$C_6H_6$ .	$H_2O$ .	$C_6H_5OH$ .	$C_6H_6$ .	$H_2O$ .
0	99.95	0.05	0	0.198	99.802
4.78	94.98	0.24	1.43	0.21	98.36
17.36	81.83	0.81	2.80	0.21	96.99
21.15	77.22	1.63	3.01	0.21	96.77
28.01	69.81	2.18	3.35	0.21	96.44
44.39	50.56	5.05	4.07	0.19	95.74
55.80	36.13	8.07	4.58	0.19	95.23
74.5	3	22.5	5.65	0.17	94.18
70.70	0	29.29	8.195	0	91.805

Data for this system are also given by Rózsa (1911).

The coefficient of distribution of phenol between olive oil and water at 25° conc. in oil ÷ conc. in  $H_2O$ , is given by Boesken and Waterman (1911) as greater than 9 and less than 10.3. The figure was obtained by dividing the solubility of phenol in olive oil by the solubility in water, each being determined separately. Results for this system are also given by Reichel (1909).

According to Greenish and Smith (1903), 100 cc. of olive oil dissolve about 50 gms. of phenol at 15.5°. These authors report that 100 cc. of glycerol dissolve about 300 gms. of phenol at 15.5°.



# ION OF PHENOL BETWEEN WATER AND CARBON TETRA CHLORIDE AT 20°.

(Vaubel — J. pr. Ch. [2] 67, 476, '03.)

mol	Volumes of Solvents.	Grams Phenol in:	
		H <sub>2</sub> O Layer.	CCl <sub>4</sub> Layer.
50 cc. H <sub>2</sub> O +	10 cc. CCl <sub>4</sub>	0.8605	0.1285
"	+ 20 cc. "	0.7990	0.1900
"	+ 30 cc. "	0.7275	0.2615
"	+ 50 cc. "	0.6435	0.3455
"	+ 100 cc. "	0.4680	0.5210
"	+ 150 cc. "	0.3645	0.6245
"	+ 200 cc. "	0.3240	0.6650

# ON OF PHENOL BETWEEN WATER AND ORGANIC SOLVENTS AT 25°.

(Herz and Rathmann, 1913.)

or:

Chloroform.	H <sub>2</sub> O and Carbon Tetrachloride.		H <sub>2</sub> O and Tetrachlor Ethane.	
	Mols. C <sub>6</sub> H <sub>5</sub> OH per Liter.		Mols. C <sub>6</sub> H <sub>5</sub> OH per Liter.	
	CHCl <sub>3</sub> Layer.	H <sub>2</sub> O Layer. CCl <sub>4</sub> Layer.	H <sub>2</sub> O Layer. C <sub>2</sub> H <sub>2</sub> Cl <sub>4</sub> Layer.	
0.254	0.0605	0.0247	0.023	0.061
0.761	0.140	0.072	0.0345	0.094
1.27	0.213	0.141	0.081	0.265
3.36	0.355	0.392	0.114	0.406
5.43	0.489	1.47	0.151	0.617
	0.525	2.49	0.155	0.651
Pentachlor ane.	H <sub>2</sub> O and Trichlor Ethylene.		H <sub>2</sub> O and Tetrachlor Ethylene.	
	Mols. C <sub>6</sub> H <sub>5</sub> OH per Liter.		Mols. C <sub>6</sub> H <sub>5</sub> OH per Liter.	
	C <sub>2</sub> HCl <sub>3</sub> Layer.	H <sub>2</sub> O Layer. CHCl <sub>3</sub> :CCl <sub>4</sub> Layer.	H <sub>2</sub> O Layer. CCl <sub>3</sub> :CCl <sub>4</sub> Layer.	
0.0495	0.044	0.046	0.0653	0.0277
0.110	0.101	0.107	0.143	0.0650
0.226	0.180	0.236	0.327	0.198
0.432	0.236	0.388	0.421	0.411
0.708	0.277	0.555	0.490	0.684
1.170	0.339	0.986		

# DISTRIBUTION OF PHENOL AT 25° BETWEEN:

(Herz and Fischer — Ber. 38, 1143, '05.)

ter and Toluene.

Water and *m* Xylene.

H <sub>2</sub> OH c.	Grams C <sub>6</sub> H <sub>5</sub> OH per 100 cc.		Millimols C <sub>6</sub> H <sub>5</sub> OH per 10 cc.		Grams C <sub>6</sub> H <sub>5</sub> OH per 100 cc.	
	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub> Layer.	H <sub>2</sub> O Layer.	<i>m</i> C <sub>6</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>2</sub> Layer.	H <sub>2</sub> O Layer.	<i>m</i> C <sub>6</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>2</sub> Layer.	H <sub>2</sub> O Layer.
.724	1.169	0.681	1.610	1.071	1.514	1.007
.469	2.865	1.381	4.787	2.726	4.501	2.563
.200	4.389	2.068	12.210	5.168	11.22	4.866
.861	6.061	2.691	22.718	6.994	21.36	6.577
.750	14.07	4.467	34.827	8.124	32.75	7.646
.346	16.69	5.027	51.352	9.123	48.28	8.576
.706	44.20	7.246	77.703	10.050	73.07	9.456
.087	50.58	7.604				
.651	84.89	9.074				



FREEZING-POINT DATA (Solubilities, see footnote, p. 1) ARE GIVEN FOR MIXTURES OF PHENOL AND EACH OF THE FOLLOWING COMPOUNDS:

Dimethylpyrone. (Kendall, 1914a.)	Bromotoluene. (Paterno and Ampola, 1897)
Phenylhydrazine. (Cuisa and Bernardi, 1910.)	<i>o</i> Toluidine. (Kremann, 1906.)
Picric Acid. (Philip, 1903; Kremann, 1904.)	<i>p</i> Toluidine. (Kremann, 1906; Philip, 1903)
Picric Acid + Other Cm'p'ds. (Kremann, '04.)	Urea (Kremann & Rodenis, 1906; Philip, 1903)
Pyridine. (Bramley, 1916; Hatcher & Skirrow, 1917.)	Methyl Urea. (Kremann, 1910.)
Quinoline. (Bramley, 1916.)	<i>as</i> Dimethyl Urea. "
Resorcinol. (Jaeger, 1907.)	<i>s</i> Dimethyl Urea. "
Sulfuric Acid. (Kendall and Carpenter, 1914.)	Urethan. (Mascarelli & Pestalozza, 1908, 1909)
Thymol. (Paterno and Ampola, 1897.)	<i>p</i> Xylene. (Paterno and Ampola, 1897.)
	<i>m</i> Xylidene. (Kremann, 1906.)

PHENOLATE of Phenyl Ammonium.

SOLUBILITY IN WATER.

(Alexejew, 1886.)

The determinations were made by the synthetic method (see p. 16). The results were plotted and the following figures read from the curve:

t°.	Gms. Phenolate per 100 Gms.		t°.	Gms. Phenolate per 100 Gm	
	Aq. Layer.	Phenolate Layer.		Aq. Layer.	Phenolate Lm
10	3	94	110	9	76
30	4	93	120	12	69
50	5	91	130	17.5	60
70	6	87.5	140 crit. temp.		40
90	7	83			

AminoPHENOLS. See last line p. 138.

*s* TribromoPHENOL  $C_6H_2Br_3OH$ .

Data for the solubility of mixtures of symmetrical tribromophenol and symmetrical trichlorophenol in diluted methyl alcohol at 25° are given by Küster and Würfel (1904-05). The results are presented in terms which are not clearly explained

SOLUBILITY OF MIXTURES OF *s* TRIBROMO PHENOL AND *s* TRICHLORO PHENOL IN METHYL ALCOHOL AT 25°.

(Thiel, 1903; from Würfel, 1896.)

Molecular per cent $C_6H_2OH.Br_3$		Solubility of		Total.
In Solid.	In Solution.	$C_6H_2OH.Cl_3$ .	$C_6H_2OH.Br_3$ .	
0	0	0.204	0	0.204
4.49	3.59	0.194	0.007	0.201
10.13	7.58	0.191	0.016	0.206
16.28	12.15	0.172	0.024	0.196
62.44	13.07	0.204	0.031	0.235
69.88	15.86	0.150	0.028	0.178
81.76	19.01	0.096	0.023	0.118
84.66	24.05	0.069	0.022	0.091
87.53	32.46	0.043	0.021	0.063
93.62	47.87	0.021	0.019	0.040
100.0	100.0	0.0	0.019	0.019

NitroPHENOLS  $C_6H_4(OH)NO_2$  *o*, *m* and *p*.

100 gms. sat. solution in water contain 0.208 gm. *o* nitrophenol at 20°.

" " " " 2.14 gms. *m* " " " (Vaubert)

" " " " 1.32 " *p* " " "

F.-pt. data for mixtures of *m* nitrophenol and water and for *p* nitrophenol and water are given by Bogojawlewsky, Winogradow, and Bogolubow (1906).



**NITROPHENOLS**  $C_6H_4(OH).NO_2$  *o*, *m* and *p*.

**SOLUBILITY OF EACH SEPARATELY IN WATER.** (Sidgwick, Spurrell and Davies, 1915.)

Gms. per 100 Gms. Sat. Sol.			t°.	Gms. per 100 Gms. Sat. Sol.		
Ortho.	Meta.	Para.		Ortho.	Meta.	Para.
0.330*	3.02*	3.28	100	1.078	...	...
0.388	3.68	4.22	110	1.37	...	...
0.463	4.54	5.53	120	1.59	...	...
0.560	5.80	7.50	120	1.91	...	...
0.685	7.90	10.85	140	2.32	...	...
0.856	11.69	21.2	150	2.90	...	...
t. ...	...	∞	160	3.75	...	...
t. ...	∞	...	200+	crit. t.	∞	...

Table indicates that a solid phase is present.

Refractive index determinations were made by the synthetic method. M. pt. of *o* = 95.1°, of *p* = 113.8°. Triple pt. for *o* = 43.5° at conc. 99.48 and = 41.5° at conc. 74 and 3.16; for *p* = 39.6° at conc. 71.2 and 3.26.

Sat. solution in water contains 3.89 gms. *o* nitrophenol at 48°.

Sat. solution in 1.0 *n*  $C_6H_4(ONa)NO_2$  contains 9.6 gms. *o* nitrophenol (Sidgwick, '10.)

**SOLUBILITY OF *o* NITROPHENOL IN LIQUID CARBON DIOXIDE.** (Büchner, 1905-6.)

t°.	Gms. <i>o</i> $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol.	t°.	Gms. <i>o</i> $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol.
-52	1.9	12.5	10
-40	2.5	14	21.2
-20	3.8	15	33.8
0	5.2	16	48.5
+10	7.7	20	60.7

5% formic acid dissolve 16.06 gms. *o*  $C_6H_4(OH)NO_2$  at 20.8°. (Aschan, '13.)

5% formic acid dissolve 23.44 gms. *p*  $C_6H_4(OH)NO_2$  at 18.6°.

of sat. solution of the pale yellow form of *p* nitrophenol in benzene, gms. *p*  $C_6H_4(OH)NO_2$  at 5°, determined by the f.-pt. method.

(Sidgwick, 1915.)

**SOLUBILITY OF THE THREE NITROPHENOLS, SEPARATELY, IN TOLUENE, BENZENE AND IN ETHYLENE DIBROMIDE.** (Sidgwick, Spurrell and Davies, 1915.)

$C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol.			t°.	Gms. <i>p</i> $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol.		
CH <sub>3</sub> .	In $C_6H_5Br$ .	In $C_2H_4Br_2$ .		In $C_6H_5CH_3$ .	In $C_6H_5Br$ .	In $C_2H_4Br_2$ .
9	...	40	70	18.5	...	31
2	48.8	47.8	80	28.1	32.7	52
6	57.7	56.8	90	54.4	59.7	73.2
6	67.2	67.2	100	79.6	80.6	88.5
5	78.3	79	110	96.3	96.3	98
1	89.7	90.6				

<i>m</i> $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol. in $C_6H_5CH_3$ .		t°.	Gms. <i>m</i> $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol. in $C_6H_5CH_3$ .		t°.	Gms. <i>m</i> $C_6H_4(OH)NO_2$ per 100 Gms. Sat. Sol. in $C_6H_5CH_3$ .	
4.63	64.8		16.44	78.5		70.50	
6	67.7		20.26	82.3		79.57	
7.03	71.5		33.16	88.8		91.43	
9.11	74.5		46.93	95.1		100	
11.28	75.7		57.71				

**NITROPHENOL**  $C_6H_4.OH.(NO_2)_2$ .

abs. methyl alcohol dissolve 6.3 gms.  $C_6H_4.OH.(NO_2)_2$  at 19.5°.

abs. ethyl alcohol dissolve 3.9 gms.  $C_6H_4.OH.(NO_2)_2$  at 19.5°. (de Bruyn, '92.)



FREEZING-POINT DATA (Solubility, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES CONTAINING SUBSTITUTED PHENOLS.

<i>o</i> Bromophenol + <i>p</i> Bromophenol.	(Holleman and Rinks, 1911.)
<i>o</i> Chlorophenol + <i>p</i> Chlorophenol.	" "
<i>o</i> Iodophenol + <i>p</i> Iodophenol.	" "
<i>s</i> Tribromophenol + <i>s</i> Trichlorophenol.	(Küster and Würfel, 1904.)
2,4,6 Tribromophenol + Acetyl tribromophenol.	(Boeseken, 1912.)
<i>o</i> Chlorophenol + Quinoline.	(Bramley, 1916.)
+ Pyridine.	" "
<i>o</i> Nitrophenol + Acetyl <i>o</i> Nitrophenol.	(Boeseken, 1912.)
<i>o</i> Nitrophenol + $\alpha$ Dinitrophenol.	(Crompton and Whitely, 189.)
+ <i>p</i> Toluidine.	(Pawlewski, 1893; Philip, 190.)
<i>p</i> Nitrophenol + <i>p</i> Nitrosophenol.	(Jaeger, 1908.)
Each of <i>o</i> , <i>m</i> and <i>p</i> Nitrophenol + Dimethylpyrone.	(Kendall, 1914a.)
" " " + Picric Acid.	(Kremann and Rodenis, 1906.)
" " " + Sulfuric Acid.	(Kendall and Carpenter, 1914.)
" " " + Urea.	(Kremann and Rodenis, 1906.)
2,4 Dinitrophenol + Dimethylpyrone.	(Kendall, 1914a.)

**PHENOLPHTHALEIN**  $(C_6H_5OH)_2CO.C_6H_5CO.$

100 gms. $H_2O$	dissolve	0.0175 gm. phenolphthalein at 20°.	(Acree and Slagle, 190.)
" "	"	0.04 "	" at 20-25°.
" Pyridine	"	796. gms.	" " "
" aq. 50% pyridine	"	300 "	" " "

**PHENYL ALANINE**  $\alpha C_6H_5NHCH(CH_3)COOH.$

Data for the solubility of phenyl alanine in aqueous salt solutions at 20° are given by Würgler (1914) and Pfeiffer and Würgler (1916).

**PHENYLENE DIAMINES** *o*, *m*, and *p*.  $C_6H_4(NH_2)_2.$

SOLUBILITY IN WATER AT 20°. (Vaubel, 1895.)

100 cc. sat. solution contain 23.8 gms. <i>m</i> $C_6H_4(NH_2)_2$ , $d_{20}$ of sat. sol. = 1.0317.
100 cc. sat. solution contain 3.7 gms. <i>p</i> $C_6H_4(NH_2)_2$ , $d_{20}$ of sat. sol. = 1.0038.

RATIO OF DISTRIBUTION BETWEEN WATER AND BENZENE AT 25°.

(Farmer and Warth, 1904.)

Results for <i>o</i> Phenylene Diamine.			Results for <i>m</i> Phenylene Diamine.		
Gms. <i>o</i> $C_6H_4(NH_2)_2$ per:		Ratio conc. $C_6H_4$ conc. $H_2O$	Gms. <i>m</i> $C_6H_4(NH_2)_2$ per:		Ratio conc. $C_6H_4$ conc. $H_2O$
50 cc. $C_6H_6$ .	1000 cc. $H_2O$ .		50 cc. $C_6H_6$ .	1000 cc. $H_2O$ .	
0.0273	0.9818	0.556	0.0828	9.088	0.182
0.2040	7.5470	0.541	0.0463	5.260	0.176

**PHENYL HYDRAZINE**  $C_6H_5NH.NH_2.$

RECIPROCAL SOLUBILITY OF PHENYLHYDRAZINE AND WATER, DETERMINED BY THE FREEZING-POINT METHOD. (Blanksma, 1910.)

t°.	Gms. $C_6H_5NH.NH_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $C_6H_5NH.NH_2$ per 100 Gms. Sat. Sol.	Solid Phase.
0	0	Ice	19.8	60.1	$C_6H_5NH.NH_2.H_2O$
- 0.3	2.2	"	20.4	64.2	"
- 0.6	3.9	"	21.8	75	"
- 0.7	4.6	" + $C_6H_5NH.NH_2.H_2O$	23	79.2	"
+ 1	4.7	$C_6H_5NH.NH_2.H_2O$	24.2	83.7	"
7	6	"	26.1	91	"
11.6	7	"	26.2	92.3	"
15	8	"	25.7	93.7	"
16.8	9.6	"	23.2	97.2	"
19.6	10.9	"	17	98.8	"
			16.6	99	" + $C_6H_5NH.NH_2$
			19.6 m. pt.	100	$C_6H_5NH.NH_2$

Between the concentrations 10.9 and 60.1, two liquid layers are formed. See p. 487.



## LOCAL SOLUBILITY OF PHENYL HYDRAZINE AND WATER. (Con.)

temperatures of separation into two liquid layers of mixtures containing 60 per cent  $C_6H_5NH.NH_2$ , are:

Gms. $C_6H_5NH.NH_2$ per 100 Gms. Mixture.	t° of Separation.	Gms. $C_6H_5NH.NH_2$ per 100 Gms. Mixture.	t° of Separation.	Gms. $C_6H_5NH.NH_2$ per 100 Gms. Mixture.
11.6	54.6	29.7	50.6	48.9
13.8	55.1	31.4	50	51.2
16.5	55.2 crit. t.	33.6	46	53.5
18.7	55.2	36.9	44.2	54.7
21.9	55	39.3	39.6	56.7
25.2	54	41.7	24	59.5
28.3	52.6	46	19.8	60.1

all data for concentrations of  $C_6H_5NH.NH_2$  above 60 per cent, are given (13).

PHENYL HYDRAZINE  $C_6H_5NH.NHC_7H_5O$ .SOLUBILITY IN AQUEOUS ALCOHOL AT 25°.  
(Holleman and Antusch, 1894.)

Gms. Hydrazine per 100 g. Solvent.	Sp. Gr. Solutions.	Vol. % Alcohol.	Gms. Hydrazine per 100 g. Solvent.	Sp. Gr. Solutions.
2.39	0.793	80	1.59	0.859
2.43	0.814	70	1.08	0.884
3	0.822	55	0.51	0.917
2.26	0.831	40	0.16	0.946

these results give an irregular curve. See remarks under  $\alpha$  acetnaph-3.



careful determinations of the solubilities of the enantiotropic forms of these compounds in alcohol, chloroform, ethyl acetate, acetone, benzene and alcohol are given by Chattaway and Lambert (1915). See also p. 312.

PHENYL HYDRAZONE  $(CH_3)_2C.N_2HC_6H_5$ .

THE SYSTEM ACETONE PHENYL HYDRAZONE + WATER ARE GIVEN BY BLANKSMA (1912).

the following results were obtained for the solubility of  $(CH_3)_2C.N_2HC_6H_5.H_2O$

t°.	Gms. $(CH_3)_2C.N_2HC_6H_5$ per 100 cc. Solution.	Solid Phase.
0	0.000	$(CH_3)_2C.N_2HC_6H_5.H_2O$
15	0.187	"
32.8	0.412	"

**PHENYL SELENIDE** and **TELLURIDE**  $(C_6H_5)_2SeBr_2, (C_6H_5)_2TeBr_2$ . the solubility of mixtures of dibromophenyl selenide and dibromotelluride in benzene at 21° are given by Pellini (1906).

LUCINOL 1.2.3  $C_6H_5(OH)_2.2H_2O$ .

1.2.3	dissolve	1.13 gms.	phloroglucinol at 20-25°.	(Dehm, '17.)
pyridine	"	296	"	"
q. 50% pyridine	"	134	"	"



# PHOSPHO MOLYBDIC ACID 488

## PHOSPHO MOLYBDIC ACID $P_2O_5 \cdot 20MoO_3 \cdot 52H_2O$ .

SOLUBILITY IN ETHER. (Parmentier, 1887.)

t°.	0°.	8.1°.	19.3°.	27.4°.	32.9°.
Gms. Acid per 100 gms. Ether	80.6	84.7	96.7	103.9	107.9

## PHOSPHORUS P. (yellow)

SOLUBILITY IN BENZENE.

(Christomanos — Z. anorg. Ch. 45, 136, '05.)

t°.	Gms. P per 100 Gms. $C_6H_6$ .	Sp. Gr. of Solution.	t°.	Gms. P per 100 Gms. $C_6H_6$ .	Sp. Gr. of Solution.	t°.	Gms. P per 100 Gms. $C_6H_6$ .
0	1.513	...	23	3.399	0.8875	50	6.80
5	1.99	...	25	3.70	0.8861	55	7.32
8	2.31	0.8990	30	4.60	...	60	7.90
10	2.4	0.8985	35	5.17	...	65	8.40
15	2.7	0.894	40	5.75	...	70	8.90
18	3.1	0.892	45	6.11	...	75	9.40
20	3.2	0.890				81	10.03

## SOLUBILITY OF PHOSPHORUS IN ETHER.

(Christomanos.)

t°.	Gms. P per 100 Gms. $(C_2H_5)_2O$ .	Sp. Gr. of Solutions.	t°.	Gms. P per 100 Gms. $(C_2H_5)_2O$ .	Sp. Gr. of Solutions.	t°.	Gms. P per 100 Gms. $(C_2H_5)_2O$ .
0	0.434	...	15	0.90	0.723	28	1.60
5	0.62	...	18	1.01	0.719	30	1.75
8	0.79	0.732	20	1.04	0.718	33	1.80
10	0.85	0.729	23	1.12	0.722	35	2.00
			25	1.39	0.728		

## SOLUBILITY OF YELLOW PHOSPHORUS IN SEVERAL SOLVENTS AT 15°.

(Stich, 1903.)

Solvent.	Gms. P per 100 Gms. Solution.
Almond Oil	1.25
Oleic Acid	1.06
Paraffin	1.45
Water	0.0003
Acetic Acid (96%)	0.105

## SOLUBILITY OF PHOSPHORUS IN CARBON DISULFIDE.

(Cohn and Inouye, 1910.)

t°.	Gms. P per 100 Gms. Sat. Sol.	t°.	Gms. P per 100 Gms. Sat. Sol.	t°.	Gms. P per 100 Gms. Sat. Sol.
-10	31.40	-3.5	66.14	0	81.27
-7.5	35.85	-3.2	71.72	+5	86.3
-5	41.95	-2.5	75	10	89.8

The above determinations were made with very great care. The authors show that the previous determinations of Giran (1903) are inaccurate. 100 gms. alcohol ( $d = 0.799$ ) dissolve 0.312 gm. P, cold, and 0.416 gm., hot. (Büchner) 100 gms. glycerol ( $d_{18} = 1.256$ ) dissolve 0.25 gms. P at 15-16°. (Ossendowski, 1907.) Red phosphorus is completely insoluble in turpentine even up to 270° provided the determination is made without access of air (sealed tube). If air is not excluded a portion of the red phosphorus may be converted to yellow phosphorus which would dissolve. (Colson, 1907.)



RECIPROCAL SOLUBILITY OF PHOSPHORUS AND SULFUR, DETERMINED BY  
THE SYNTHETIC (Sealed Tube) METHOD.

(Giran, 1906.)

pieces of P and S were sealed in small tubes and first heated to about 200° combination. They were then cooled to the solidification point and reheated to the temperature at which the last crystal disappeared. The results, which were read from the diagram, show the eutectics and maxima of the curves.)

Eutectics.			Maxima of Curves.		
Mols. % S in Mixture.	Solid Phase.	t°.	Mols. % S in Mixture.	Solid Phase.	
33.5	P <sub>4</sub> S <sub>3</sub> +P <sub>4</sub>	+167	43.6	P <sub>4</sub> S <sub>3</sub>	
50	P <sub>4</sub> S <sub>3</sub> +P <sub>2</sub> S <sub>5</sub>	296	60.8	P <sub>2</sub> S <sub>5</sub>	
67.5	P <sub>2</sub> S <sub>5</sub> +P <sub>2</sub> S <sub>7</sub>	272	72.1	P <sub>2</sub> S <sub>7</sub>	
75	P <sub>2</sub> S <sub>7</sub> +P <sub>2</sub> S <sub>10</sub>	314	86.1	P <sub>2</sub> S <sub>10</sub>	

Additional data for this system are given by Boulouch (1902 and 1906) and by Giran (1906).

PHOSPHORUS SULFIDES P<sub>4</sub>S<sub>3</sub>, P<sub>4</sub>S<sub>7</sub>, P<sub>4</sub>S<sub>10</sub>.

SOLUBILITY IN CARBON DISULFIDE, BENZENE, AND IN TOLUENE.

(Stock, 1910.)

Gms. P <sub>4</sub> S <sub>3</sub> per 100 Gms.:			Gms. P <sub>4</sub> S <sub>7</sub> per 100 Gms. CS <sub>2</sub> .	Gms. P <sub>4</sub> S <sub>10</sub> per 100 Gms. CS <sub>2</sub> .
CS <sub>2</sub> .	C <sub>6</sub> H <sub>6</sub> .	C <sub>6</sub> H <sub>5</sub> Cl <sub>12</sub> .		
11.1	...	...	...	0.083
27	...	...	0.005	0.182
100	2.5	3.125	0.0286	0.223
...	11.1	...	...	...
...	...	15.4	...	...

ORTHOPHOSPHORIC ACID (ortho) H<sub>3</sub>PO<sub>4</sub>.

SOLUBILITY IN WATER. (Smith and Menzies, 1909.)

The solutions were analyzed by titration. The mixtures were constantly stirred at least two hours.)

Gms. H <sub>3</sub> PO <sub>4</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. H <sub>3</sub> PO <sub>4</sub> per 100 Gms. Sat. Sol.	Solid Phase.
62.9	Ice + 2H <sub>3</sub> PO <sub>4</sub> .H <sub>2</sub> O	24.38	94.80	10H <sub>3</sub> PO <sub>4</sub> .H <sub>2</sub> O
76.7	2H <sub>3</sub> PO <sub>4</sub> .H <sub>2</sub> O	24.40	94.84	"
78.7	"	24.81	94.95	"
81.7	"	25.41	95.26	"
85.7	"	25.85	95.54	"
87.7	"	26.2*	...	" + H <sub>3</sub> PO <sub>4</sub>
90.5	"	26.23	95.90	H <sub>3</sub> PO <sub>4</sub>
91.6	"	27.02	95.98	"
92.5	"	29.42	96.15	"
93.4	"	29.77	96.11	"
94.1	"	37.65	97.80	"
...	" + 10H <sub>3</sub> PO <sub>4</sub> .H <sub>2</sub> O	39.35	98.48	"
94.78	10H <sub>3</sub> PO <sub>4</sub> .H <sub>2</sub> O	42.30†	100	"

\* Eutec.

† M. pt.

— The results of Giran (1908), determined by the freezing-point method, are to be erroneous, due to supercooling which would result from failure to crystallization by inoculation. Data for mixtures of phosphoric and phosphorus acids are given by Rosenfelder and Jakobsohn (1906).



# PHOSPHORIC ACID

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## PyroPHOSPHORIC ACID $\text{H}_4\text{P}_2\text{O}_7$ .

SOLUBILITY IN WATER. (Giran, 1908; see note on preceding page.)

t°.	Gms. $\text{H}_4\text{P}_2\text{O}_7$ per 100 Gms. Sat. Sol.	Solid Phase.
-75	59	Ice + $\text{H}_4\text{P}_2\text{O}_7 \cdot 1\frac{1}{2}\text{H}_2\text{O}$
+26 m. pt.	86.8	$\text{H}_4\text{P}_2\text{O}_7 \cdot 1\frac{1}{2}\text{H}_2\text{O}$
23	88.8	" + $\text{H}_4\text{P}_2\text{O}_7$
61 m. pt.	100	$\text{H}_4\text{P}_2\text{O}_7$

## HypoPHOSPHORIC ACID $\text{H}_2\text{PO}_3\text{H}_2\text{O}$ .

100 gms. sat. solution in water contain 81.8 gms.  $\text{H}_2\text{PO}_3$  at the m. pt., 62°, of the hydrated compound,  $\text{H}_2\text{PO}_3\text{H}_2\text{O}$ . (Rosenheim and Friess, 1904)

## PHTHALIC ACIDS $\text{C}_6\text{H}_4(\text{COOH})_2$ , *o*, *m* and *p*.

SOLUBILITY OF EACH IN WATER. (Vaubel, 1895, 1899.)

Acid.	t°.	Gms. per 100 Gms. Solution.
<i>o</i> Phthalic Acid	14	0.54
<i>m</i> = Isophthalic Acid	25	0.013
<i>p</i> = Terephthalic Acid	...	almost insoluble

## MELTING TEMPERATURES OF MIXTURES OF *o* PHTHALIC ACID AND WATER (Flaschner and Rankin, 1910.)

(The determinations were made by the sealed tube method of Alexejew.)

Wt. % Acid	14.4	28.2	30.6	49.3	75	100
Saturation Temp.	97°	111.5°	121.2°	130°	162°	231°
Unstable boundary	...	...	...	27°	84°	...

## SOLUBILITY OF *o* PHTHALIC ACID IN ALCOHOL AND IN ETHER AT 15°. (Bourgoin, 1878.)

Solvent.	Gms. $\text{C}_6\text{H}_4(\text{COOH})_2$ per 100 Gms.	
	Solution.	Solvent.
Absolute Alcohol	9.156	11.70
90 per cent Alcohol	10.478	10.08
Ether	0.679	0.684

## SOLUBILITY OF *o* PHTHALIC ACID IN ALCOHOLS. (Timofeiew, 1894.)

Alcohol.	t°.	Gms. $\text{C}_6\text{H}_4(\text{COOH})_2$ per 100 Gms. Sat. Sol.	Alcohol.	t°.	Gms. $\text{C}_6\text{H}_4(\text{COOH})_2$ per 100 Gms. Sat. Sol.
Methyl Alcohol	- 2	15.1	Ethyl Alcohol	21.4	11.65
" "	+19	19.5	Propyl Alcohol	- 3	3.42
" "	+21.4	20.4	" "	+19	5.27
Ethyl Alcohol	- 2	8.2	" "	22	5.54
" "	+19	11	" "	23	5.70

## DISTRIBUTION OF *o* PHTHALIC ACID AND OF *m* PHTHALIC ACID (ISOPHTHALIC) BETWEEN WATER AND ETHER AT 25°. (Chandler, 1908.)

Results for *o* Phthalic Acid.

Mols. $\text{C}_6\text{H}_4(\text{COOH})_2$ per Liter:	Ratio $\frac{a}{b}$ .	Ratio for Unionized Acid.
$\text{H}_2\text{O}$ Layer, a. Ether Layer, b.		
0.0261 0.0322	0.809	0.637
0.0131 0.0150	0.873	0.645
0.0085 0.0091	0.932	0.667
0.0056 0.0056	1.006	0.635

Results for *m* Phthalic Acid.

Mols. $\text{C}_6\text{H}_4(\text{COOH})_2$ per Liter:	Ratio $\frac{a}{b}$ .	Ratio to Unionized Acid
$\text{H}_2\text{O}$ Layer, a. Ether Layer, b.		
0.000398 0.0485	0.0821	0.031
0.000272 0.0288	0.0943	0.03
0.000263 0.0279	0.0944	0.03
0.000252 0.0266	0.0949	0.03

Ratio of solubilities of Phthalic acids in olive oil and water at 25°.

(Böeseken and Waterman, 1911)

*o* Phthalic acid, solubility in oil ÷ solubility in  $\text{H}_2\text{O}$  = 0.01.

*p* Phthalic acid (Terephthalic), solubility in oil ÷ solubility in  $\text{H}_2\text{O}$  = 0.55.

100 gms. 95% formic acid dissolve 0.55 gm. *p* phthalic acid (Terephthalic) (Aschmann, 1902).



**PHTHALIC ACIDS** *o* and *m* (Iso)  $C_6H_4(NO_2)(COOH)_2$ .

**SOLUBILITY OF THE SEVERAL NITRO PHTHALIC ACIDS IN WATER AT 25°.**  
(Holleman and Huisinga, 1908.)

Acid.	M. pt.	Gms. Acid per 100 Gms. Sat. Solution.
Ortho Phthalic Acid	220	2.048
" " " "	164-166	very soluble
metrical Nitro Iso Phthalic Acid (anhy.)	255-256	0.220
" " " " (hydrated)	255-256	0.157
metrical " " " "	245	0.967
al " " " "	300	0.216

The authors also give several tables showing the solubility of one of the above compounds in aqueous solutions of another. These data are made the basis of a genious solubility method for determining the composition of unknown mixtures of these compounds.

**PHTHALIC ANHYDRIDE**  $C_6H_4<\begin{smallmatrix} CO \\ CO \end{smallmatrix}>O$ .

**SOLUBILITY IN WATER.**  
(van der Stadt, 1902.)

determinations, except first three, made by the Synthetic Method. See

Gms. $C_6H_4O_3$ per 100 Gms.		Mol. per cent $C_6H_4O_3$ .	t°.	Gms. $C_6H_4O_3$ per 100 Gms.		Mol. per cent $C_6H_4O_3$ .
Water.	Solution.			Water.	Solution.	
0.00295	0.00295	0.00036	189.5	1076	91.66	56.73
0.6194	0.6150	0.0754	188.8	1265	92.68	60.63
1.630	1.604	0.198	187.1	1474	93.65	64.22
94.3	48.54	10.30	181.8	2332	95.88	73.95
210	67.75	20.36	176.2	3334	97.07	80.23
319.3	76.13	27.98	169.4	5745	98.28	87.49
449.6	81.81	35.37	130.9	37570	99.72	97.89
546.1	84.50	39.93	131	83010	99.86	99.02
821.5	89.19	50	131.2	∞	100	100
863.4	89.62	51.24				

**SOLUBILITY OF PHTHALIC ANHYDRIDE IN CARBON DISULFIDE.**

(Arctowski, 1895; Etard, 1894.)

t°.	Gms. $C_6H_4O_3$ per 100 Gms. Solution.	t°.	Gms. $C_6H_4O_3$ per 100 Gms. Solution.	t°.	Gms. $C_6H_4O_3$ per 100 Gms. Solution.
112.5	0.013	+10	0.3	70	2.3
93	0.013	20	0.7	90	3.7
77.5	0.016	30	0.8	100	5
40	0.03	40	1.2	120	8
20	0.06	50	1.3	140	13.3
10	0.10	60	1.7	160	20.7
0	0.20			180	30.2

**Gms.** 95% formic acid dissolve 4.67 gms. phthalic anhydride at 19.8°.

**Gms.** pyridine dissolve 83.5 gms. phthalic anhydride at 20-25°. (Aschan, 1913.)

(Dehn, 1917.)



# **PHTHALIMIDE**

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**PHTHALIMIDE**  $\text{o C}_6\text{H}_4 < (\text{CO})_2 > \text{NH}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 0.06 gm. phthalimide at 20–25°. (Dehn, 1917.)  
 " pyridine " 14.15 gms. " " "  
 " aq. 50% pyridine " 7.74 " " "

**PHTHALONIC ACID**  $\text{COOH.C}_6\text{H}_4.\text{CO.COOH.2H}_2\text{O}$ .

100 gms. sat. solution in water contain 64.4 gms. anhydrous acid at 15°, Sp. Gr. of sat. solution = 1.243. (Tcherniac, 1916.)

Amide of **PHTHALIDECARBOXYLIC ACID**  $\text{C}_6\text{H}_4 < \begin{smallmatrix} \text{CH}(\text{CONH}_2) \\ \text{CO} \end{smallmatrix} > \text{O}$  (m. pt. 185.5°).

100 gms.  $\text{H}_2\text{O}$  dissolve 0.132 gm. of the acid at 16.2° and 5.7 gms. at b. pt. (Tcherniac, 1916.)

**PHYSOSTIGMINE** (Eserine)  $\text{C}_{15}\text{H}_{21}\text{N}_3\text{O}_7$ .

Water dissolves only traces of physostigmine. 100 gms. of a solvent composed of 3 gms.  $\text{H}_3\text{BO}_3$  per 100 cc. of aq. 50% glycerol dissolve 2.5 gms.  $\text{C}_{15}\text{H}_{21}\text{N}_3\text{O}_7$  at room temp. (Baroni and Borlinetto, 1911.)

**PHYSOSTIGMINE SALICYLATE**  $\text{C}_6\text{H}_4(\text{OH})\text{COOH.C}_{15}\text{H}_{21}\text{N}_3\text{O}_7$  and Physostigmine Sulfate  $\text{H}_2\text{SO}_4(\text{C}_{15}\text{H}_{21}\text{N}_3\text{O}_7)_2$ .

SOLUBILITY OF EACH IN WATER, ALCOHOL, ETC.  
(U. S. P. VIII.)

Solvent.	t°.	Gms. per 100 Gms. Solvent.	
		Salicylate.	Sulfate.
Water	25	1.38	very soluble
Water	80	6.66	"
Alcohol	25	7.87	"
Alcohol	60	25	"
Chloroform	25	11.6	"
Ether	25	0.57	0.083

Methylphenyl **PICRAMIDES**.

SOLUBILITY IN ETHYL ALCOHOL AT 18°.  
(Hantzsch, 1911.)

100 cc.  $\text{C}_2\text{H}_5\text{OH}$  dissolve 0.32 gm. of the isomer melting at 108°.  
 100 cc.  $\text{C}_2\text{H}_5\text{OH}$  dissolve 0.42 gm. of the isomer melting at 128°.

**PICRIC ACID**  $\text{C}_6\text{H}_3\text{OH}(\text{NO}_2)_3$  1.2.4.6.

SOLUBILITY IN WATER.

(Dolinski — Ber. 38, 1836, '05; Findlay — J. Ch. Soc. 81, 1219, '02.)

t°.	Gms. $\text{C}_6\text{H}_3\text{N}_3\text{O}_7$ per 100 Grams			t°.	Gms. $\text{C}_6\text{H}_3\text{N}_3\text{O}_7$ per 100 Grams		
	Solution.	Water.			Solution.	Water.	
0	0.67 (D.)	0.68 (D.)	1.05 (F.)	60	2.77 (D.)	2.81 (D.)	3.17 (F.)
10	.80	0.81	1.10	70	3.35	3.47	3.89
20	1.10	1.11	1.22	80	4.22	4.41	4.66
30	1.38	1.40	1.55	90	5.44	5.72	5.49
40	1.75	1.78	1.98	100	6.75	7.24	6.33
50	2.15	2.19	2.53				

Dolinski does not refer to the previous determinations of Findlay.

100 gms.  $\text{H}_2\text{O}$  dissolve 1.525 gms.  $\text{C}_6\text{H}_3\text{OH}(\text{NO}_2)_3$  at 30° and 1.868 gms. at 40°. (Karplus, 1907.)

100 gms.  $\text{H}_2\text{O}$  dissolve 1.45 gms.  $\text{C}_6\text{H}_3\text{OH}(\text{NO}_2)_3$  at 20°. (Sisley, 1902.)

100 gms  $\text{H}_2\text{O}$  containing 5 gms.  $\text{H}_2\text{SO}_4$  per liter, dissolve 0.61 gm.  $\text{C}_6\text{H}_3\text{OH}(\text{NO}_2)_3$  at 20°. (Sisley, 1902.)

100 gms. ethyl alcohol dissolve 8.37 gms.  $\text{C}_6\text{H}_3\text{OH}(\text{NO}_2)_3$  at 22°. (Timofeiew, 1894.)

100 gms. methyl alcohol dissolve 22.5 gms.  $\text{C}_6\text{H}_3\text{OH}(\text{NO}_2)_3$  at 22°. "

100 gms. propyl alcohol dissolve 3.81 gms.  $\text{C}_6\text{H}_3\text{OH}(\text{NO}_2)_3$  at 22°. "

100 gms. 95% formic acid dissolve 10.83 gms.  $\text{C}_6\text{H}_3\text{OH}(\text{NO}_2)_3$  at 19.8°. (Aschan, 1913.)



**SOLUBILITY OF PICRIC ACID IN WATER AND IN AQUEOUS SALT SOLUTIONS AT 25°.**

(Levin — Z. physik. Ch. 55, 520, '06.)

One liter of aqueous solution contains 0.05328 gram mols. = 12.20 grams  $C_6H_3OH(NO_2)_3$  at 25°.

Gm. Mols. Salt per Liter.	Gram Mols. Picric Acid per Liter in Aq. Solutions of:					
	NaCl.	NaNO <sub>3</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	LiCl.	Li <sub>2</sub> SO <sub>4</sub> .	NH <sub>4</sub> Cl.
0.01	0.05524	0.05529	0.05604	0.05480	0.05661	0.05487
0.02	0.05559	0.05872	0.05872	0.05558	0.06053	0.05540
0.05	0.05729	0.06632	0.06632	0.05703	0.06691	0.05771
0.07	0.05862	0.07093	0.07093	0.05878	0.07013	0.05865
0.10	0.05902	0.07670	0.07670	0.06132	0.07437	...
0.50	0.0790	...	...	...	0.123	...
1.00	0.1180	...	...	...	0.149	...

Gm. Mols. Salt per Liter.	Grams Picric Acid per Liter in Aq. Solutions of:					
	NaCl.	NaNO <sub>3</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	LiCl.	Li <sub>2</sub> SO <sub>4</sub> .	NH <sub>4</sub> Cl.
0.01	12.66	12.67	12.83	12.55	12.97	12.57
0.02	12.74	13.45	13.45	12.74	13.87	12.69
0.05	13.12	15.19	15.19	13.06	15.33	13.22
0.07	13.43	16.25	16.25	13.47	16.06	13.44
0.10	13.52	17.57	17.57	14.05	17.04	...
0.50	18.09	...	...	...	28.18	...
1.00	26.98	...	...	...	34.14	...

**Solubility in Aq. Cane Sugar.**

**Solubility in Aq. Grape Sugar.**

Gm. Mols. Sugar per Liter.	Picric Ac. per Liter Solution.		Sp. Gr. Solution.	Gm. Mols. Grape Sugar per Liter.	Picric Acid per Liter Sol.	
	Gm. Mols.	Gms.			G. Mols.	Gms.
0.10	0.05202	11.92	1.0122	0.10	0.0530	12.14
0.25	0.04978	11.40	1.0319	0.25	0.0521	11.93
0.50	0.0482	11.04	1.0654	0.50	0.0509	11.66
1.00	0.0443	10.15	1.1294	1.00	0.0474	10.86

**SOLUBILITY OF PICRIC ACID IN ABSOLUTE ALCOHOL.**

(Behrend — Z. physik. Ch. 10, 265, '92.)

100 gms. sat. solution contain 5.53 grams  $C_6H_3N_3O_7$  at 12.3°, and 5.92 grams at 14.8°. Sp. Gr. of the latter solution = 0.8255.

**SOLUBILITY OF PICRIC ACID IN BENZENE.**

(Findlay.)

t°.	Gms. $C_6H_3N_3O_7$ per 100 Gms. $C_6H_6$ .		Mols. $C_6H_3N_3O_7$ per 100 Mols. $C_6H_6$ .	t°.	Gms. $C_6H_3N_3O_7$ per 100 Gms. $C_6H_6$ .		Mols. $C_6H_3N_3O_7$ per 100 Mols. $C_6H_6$ .
	Gms. $C_6H_3N_3O_7$ per 100 Gms. $C_6H_6$ .	Mols. $C_6H_3N_3O_7$ per 100 Mols. $C_6H_6$ .			Gms. $C_6H_3N_3O_7$ per 100 Gms. $C_6H_6$ .	Mols. $C_6H_3N_3O_7$ per 100 Mols. $C_6H_6$ .	
5	3.70	1.26		38.4	26.15	8.88	
10	5.37	1.83		45	33.57	11.40	
15	7.29	2.48		55	50.65	17.21	
20	9.56	3.25		58.7	58.42	19.83	
25	12.66	4.30		65	71.31	24.20	
26.5	13.51	4.60		75	96.77	32.92	
35	21.38	7.26					



SOLUBILITY OF PICRIC ACID IN AQUEOUS SOLUTIONS OF HYDROCHLORIC  
ACID AT 25°.  
(Stepanow, 1910.)

(The solutions were saturated by constant agitation at constant temperature. The picric acid in the saturated solutions was determined by evaporation and weighing. The solubility passes through a minimum.)

Mols. HCl per Liter.	C <sub>6</sub> H <sub>3</sub> OH.(NO <sub>2</sub> ) <sub>3</sub> per Liter.		Mols. HCl per Liter.	C <sub>6</sub> H <sub>3</sub> OH.(NO <sub>2</sub> ) <sub>3</sub> per Liter.	
	Mols.	Gms.		Mols.	Gms.
0.25	0.0116	2.66	3.67	0.0068	1.55
0.50	0.0079	1.80	4.40	0.0082	1.87
0.75	0.0062	1.42	5.14	0.0098	2.26
1	0.0054	1.24	5.51	0.0105	2.41
1.47	0.0050	1.14	5.87	0.0115	2.65
2.20	0.0051	1.15	6.24	0.0123	2.82
2.94	0.0057	1.31	6.61	0.0125	2.86

SOLUBILITY OF PICRIC ACID IN ETHER.

(Bougault, 1903.)

Solvent.	t°.	Gms. C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>7</sub> per Liter.
Ether of Sp. Gr. 0.721	13	10.8
Ether of Sp. Gr. 0.725 (0.8 pt. H <sub>2</sub> O per 100)	13	36.8
Ether of Sp. Gr. 0.726 (1 pt. H <sub>2</sub> O per 100)	13	40
Ether saturated with H <sub>2</sub> O	15	51.2
H <sub>2</sub> O saturated with Ether	15	13.8

100 parts of ether dissolve about 2.27 gms. picric acid at 15°. (S)

" chloroform " " 2 " " " "

" petroleum ether " " 0.04 " " " "

100 gms. sat. solution in pure ether contain 5 gms. picric acid at 20°. (Sisley, 1902)

100 cc. sat. solution in pure ether contain 3.7 gms. picric acid at 20°. "

100 gms. sat. solution in pure toluene contain 12 gms. picric acid at 20°. "

100 cc. sat. solution in pure toluene contain 10.28 gms. picric acid at 20°. "

100 cc. sat. solution in pure amyl alcohol contain 1.755 gms. picric acid at 20°. "

DISTRIBUTION OF PICRIC ACID AT 25° BETWEEN:

Water and Amyl Alcohol.

(Herz and Fischer — Ber. 37, 4747, '04.)

Millimols C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>7</sub> per 10 cc.		Gms. C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>7</sub> per 100 cc.	
Aq. Layer.	Alcohol Layer.	Aq. Layer.	Alcohol Layer.
0.0553	0.0930	0.127	0.213
0.0920	0.1850	0.211	0.424
0.1613	0.4127	0.369	0.946
0.1869	0.5182	0.428	1.188
0.3161	1.079	0.724	2.473
0.4471	1.638	1.024	3.753
0.5624	2.189	1.288	5.017
0.6423	2.549	1.472	5.839

Water and Toluene.

(H. and F. — Ber. 38, 1142, '05.)

Millimols C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>7</sub> per 10 cc.		Gms. C <sub>6</sub> H <sub>3</sub> N <sub>3</sub> O <sub>7</sub> per 100 cc.	
Aq. Layer.	Toluene Layer.	Aq. Layer.	Toluene Layer.
0.075	0.126	0.172	0.289
0.109	0.230	0.250	0.527
0.163	0.482	0.374	1.104
0.244	1.026	0.559	2.351
0.389	2.347	0.891	5.380
0.496	3.747	1.137	8.586
0.583	5.135	1.336	11.770

Additional data for the distribution of picric acid between water and amyl alcohol and water and toluene at 20° are given by Sisley (1902). Very irregular results were obtained. The fact that the colors of the two layers are different, was taken to indicate that the picric acid dissolves in a different molecular form in the two layers.



## DISTRIBUTION OF PICRIC ACID AT 25° BETWEEN:

Water and Bromoform.				Water and Chloroform.			
and Levy — Z. Electrochem. 11, 820, '05.)				(H. and L.)			
Mmols. $C_6H_3N_3O_7$ per 10 cc.		Gms. $C_6H_3N_3O_7$ per 100 cc.		Millimols. $C_6H_3N_3O_7$ per 10 cc.		Gms. $C_6H_3N_3O_7$ per 100 cc.	
Aq. Layer.	Bromoform Layer.	Aq. Layer.	Bromoform Layer.	Aq. Layer.	Chloroform Layer.	Aq. Layer.	Chloroform Layer.
21	0.365	0.736	0.836	0.207	0.254	0.474	0.582
01	0.515	0.919	1.180	0.329	0.547	0.754	1.253
75	0.655	1.088	1.501	0.488	1.09	1.118	2.498
75	0.871	1.317	1.995	0.561	1.41	1.285	3.230
74	1.14	1.545	2.612	0.588	1.53	1.348	3.505

## DISTRIBUTION OF PICRIC ACID BETWEEN:

Water and Benzene. (Kurloff, 1898.) Water and Ether at 20°. (Sisley, 1902.)

Mols. Picric Acid per Liter:		Gms. Picric Acid per Liter:		Dist. Coef.
Aq. Layer.	$C_6H_6$ Layer.	Aq. Layer.	Ether Layer.	
0.0261	0.0940	6.78	17.85	2.63
0.0208	0.0779	3.74	6.70	1.79
0.0188	0.0618	2.85	3.72	1.34
0.0132	0.0359	0.85	0.11	0.13
0.0097	0.0198	0.10	0.001	0.01

and for the distribution of picric acid between water and mixtures of chloroform and toluene at 25°, are given by Herz and Kurzer (1910).

FREEZING-POINT DATA (Solubilities, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES:

Picric Acid + Dimethylpyrone.	(Kendall, 1914.)
" + Resorcinol.	(Philip and Smith, 1905.)
" + Thymol.	(Kendall, 1916.)
" + $\alpha$ Trinitrotoluene.	(Giua, 1916.)

**PICRIC ACID**  $C_6H(CH_3)(OH)(NO_2)_3$ , 1.3.2.4.6.

SOLUBILITY IN AQUEOUS SOLUTIONS AT 25°. (Kendall, 1911.)

Aq. Solvent.	Normality of Dissolved Methyl Picric Acid.	Aq. Solvent.	Normality of Dissolved Methyl Picric Acid.
7	0.0100	0.01975 % Nitrobenzoic Acid	0.0080
+ Ligroin	0.01019	0.00981 % Salicylic Acid	0.01063
+ Toluene	0.01059	0.01393 % "	0.01072
95 % HCl	0.00641	H <sub>2</sub> O + Excess of Salicylic Acid	0.02613*
93 % HCl	0.00487		
13 % Picric Acid	0.00702		

\* = normality of salicylic acid + methylpicric acid.

**PROTOXIN**  $C_{20}H_{24}O_{12}$ .

gms. H <sub>2</sub> O	dissolve	0.41 + gm. picrotoxin at 20–25°.	(Dehn, 1917.)
pyridine	dissolve 102	gms.	" "
aq. 50% pyridine	" 81	" "	" "

**PICRIC ACID**  $(CH_3)_3(COOH)_3$ .

DISTRIBUTION BETWEEN WATER AND ETHER AT 25°. (Chandler, 1908.)

Mols. $(CH_3)_3(COOH)_3$ per Liter.		Dist. Coef. $\frac{a}{b}$	Dist. Coef. Corrected for Ionisation.
Aq. Layer, a.	Ether Layer, b.		
0.00998	0.01407	0.7095	0.670
0.00702	0.00979	0.7170	0.670
0.00480	0.00667	0.7195	0.663
0.00284	0.00380	0.7480	0.663
0.00179	0.00253	0.7075	0.653



**PILOCARPINE**

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**PILOCARPINE**  $C_{11}H_{16}N_2O_2$ .100 cc. oil of sesame dissolve 0.3142 gm.  $C_{11}H_{16}N_2O_2$  at 20°. (Zaki, 1910.)**PILOCARPINE HYDROCHLORIDE**  $C_{11}H_{18}N_2O_2.HCl$ , Pilocarpine Nitrate  $C_{11}H_{18}N_2O_2.HNO_3$ , and Piperine  $C_{17}H_{19}NO_2$  in Several Solvents. (U. S. P., VIII.)

Solvent.	t°.	Gms. per 100 Gms. Solvent.		
		$C_{11}H_{18}N_2O_2.HCl$	$C_{11}H_{18}N_2O_2.HNO_3$	$C_{17}H_{19}NO_2$
Water	25	333	25	insoluble
Alcohol	25	4.35	1.66	6.66
Alcohol	60	9.09	6.2	22.7
Chloroform	25	0.18	...	58.8
Ether	25	...	...	2.8

**PINACOLIN**  $CH_3.CO.C(CH_3)_3$ .

SOLUBILITY IN WATER AND IN AQ. ACETONE AT 15°. (Delange, 1901.)

Per cent Acetone in Solvent.	cc. Pinacolin Dissolved per 100 cc. Solvent.
0 (= pure $H_2O$ )	2.44
20	3.47
33	6.06
50	9.09
60	14.27

**PINENE HYDROCHLORIDE**  $C_{10}H_{16}.HCl$ .100 gms. 95% formic acid dissolve 1.2 gms.  $C_{10}H_{16}.HCl$  at 16.8°. (Aschan, 1901.)**PIPECOLINE**  $C_8H_9(CH_2)NH$  *d* and *l*.F.-pt. data for mixtures of *d* and *l* pipercoline are given by Ladenburg and Sobceki (1910).**PIPERIDINE**  $CH_2<(CH_2.CH_2)_5>NH$ .

DISTRIBUTION BETWEEN WATER AND BENZENE AT ORD. TEMP. (Georgievics, 1912.)

Gms. Piperidine per:		Gms. Piperidine per:	
25 cc. $H_2O$ Layer.	75 cc. $C_6H_6$ Layer.	25 cc. $H_2O$ Layer.	75 cc. $C_6H_6$ Layer.
0.1573	0.4127	0.891	2.339
0.256	0.674	1.299	3.589
0.409	1.088	1.712	4.789
0.674	1.746		

**PIPERIDINE HYDROCHLORIDE**  $CH_2<(CH_2.CH_2)_5>NH.HCl$ .

SOLUBILITY IN SEVERAL SOLVENTS. (Freundlich and Richards, 1912.)

Solvent.	t°.	Mols. Piperidine HCl per Liter.
Water	0	4.87
"	25	5.19
Tetrachlor Ethane (sat. with $H_2O$ )	0	0.13
"	25	0.29
Nitrobenzene	25	0.00543
Benzene	25	0.00102

**MethylPIPERIDINES** 2-, 3-, 4-, *n* Methyl, etc.

Data for the reciprocal solubility of 2-methylpiperidine and water, 3-methylpiperidine and water, 4-methylpiperidine and water, nitrosopiperidine and water, and for *n*-methylpiperidine and water, determined by the synthetic (sealed tube) method of Alexejeff, are given by Flaschner and MacEwan (1908) and by Flaschner (1909) and (1908). Similar data for *n*-ethylpiperidine and water and propylpiperidine and water are given by Flaschner (1908).



benzyl **PIPERIDINES**  $C_{17}H_{19}N$ .

**PROPERTIES OF THE ACID SALTS OF  $\alpha\alpha'$  DIPHENYL PIPERIDINE AND OF ISO  $\alpha\alpha'$  DIPHENYL PIPERIDINE IN WATER AT 25°.**  
(Scholtz, 1901.)

Piperidine Base.	Gms. per 100 Gms. Sat. Solution:			
	HCl Salt.	HBr Salt.	HI Salt.	$H_2SO_4$ Salt.
$\alpha'$ Diphenyl Piperidine, m. pt. 71°	0.85	0.90	0.12	6.31
$\alpha'$ Diphenyl Piperidine, liquid	3.02	1	0.72	easily soluble

**NE**  $C_{17}H_{19}NO_4$ . (See also under Pilocarpine, preceding page.)

**SOLUBILITY IN SEVERAL SOLVENTS.**

Solvent.	t°.	Gms. $C_{17}H_{19}NO_4$ per 100 Gms. Solvent.	Authority.
Water	20-25	0.01	(Dehn, 1917.)
1% Alcohol	9.5	2.9	(Timofeiew, 1894.)
1% " "	9.5	4.4	"
1% " "	9.5	2.94	"
1% or Ethylene	15	9.83	(Wester and Bruins, 1914.)
1% line	20-25	22.46	(Dehn, 1917.)
50% Pyridine	20-25	11.39	"

**PLATINUM ALLOYS.**

**SOLUBILITY OF PLATINUM ALLOYS IN NITRIC ACID.**

(Winkler — Z. anal. Ch. 13, 369, '74.)

Alloy.	Approx. per cent Pt in Alloy.	Grams Alloy Dissolved per 100 Grams $HNO_3$ Solution of			
		1.398 Sp. Gr.	1.298 Sp. Gr.	1.190 Sp. Gr.	1.298 Sp. Gr.
Gold and Silver	10	57	44	69	37
"	5	69	57	51	35
"	2.5	62	61	69	..
"	1	75	70	76	..
Gold and Copper	10	46	27	11	51
"	5	36	34	14	41
"	2.5	51	40	30	..
"	1	52	41	37	..
Gold and Lead	10	7	9	8	..
"	5	8	9	10	..
"	2.5	22	17	11	..
"	1+	21	18	23	..
Gold and Bismuth	10	14	19	4	3
"	5	21	20	6	18
"	2.5	25	42	8	..
"	1	49	64	10	..
Gold and Zinc	10	10	11	19	5
"	5	16	12	6	11
"	2.5	16	24	19	..
"	1	20	32	37	..

**PLATINUM BROMIDE**  $PtBr_4$ .

1 gram sat. aqueous solution contain 0.41 gram  $PtBr_4$  at 20°.  
(Halberstadt — Ber. 17, 2962, '84.)

**NITRIC POTASSIUM BROMIDE**  $K_2PtBr_6$ .

1 gram sat. aqueous solution contain 2.02 grams  $K_2PtBr_6$  at 20°.  
(Halberstadt.)



# PLATINUM CHLORIDES

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## PLATINIC DOUBLE CHLORIDES of Ammonium, Caesium, Potassium, Rubidium and Thallium. (Data for each separately.)

### SOLUBILITY IN WATER.

(Crookes — Chem. News 9, 37, 205, '64; Bunsen — Pogg. Ann. 113, 337, '61.)

t°.	Grams per 100 Grams Water.				
	(NH <sub>4</sub> ) <sub>2</sub> PtCl <sub>6</sub> .	Cs <sub>2</sub> PtCl <sub>6</sub> .	K <sub>2</sub> PtCl <sub>6</sub> .	Rb <sub>2</sub> PtCl <sub>6</sub> .	Tl <sub>2</sub> PtCl <sub>6</sub> .
0	...	0.024	0.74	0.184	...
10	0.666 (15°)	0.050	0.90	0.154	0.0064 (15°)
20	...	0.079	1.12	0.141	...
25	...	0.095	1.26	0.143	...
30	...	0.110	1.41	0.145	...
40	...	0.142	1.76	0.166	...
50	...	0.177	2.17	0.203	...
60	...	0.213	2.64	0.253	...
70	...	0.251	3.19	0.329	...
80	...	0.291	3.79	0.417	...
90	...	0.332	4.45	0.521	...
100	1.25	0.377	5.18	0.634	0.050

## SOLUBILITY OF POTASSIUM CHLOROPLATINATE IN WATER AND IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE AND OF SODIUM CHLORIDE.

(Archibald, Wilcox and Buckley, 1908.)

Solubility in Water.			In Aq. KCl at 20°.		In Aq. NaCl at 20°.	
t°.	Gms. K <sub>2</sub> PtCl <sub>6</sub> per 100 Gms. H <sub>2</sub> O.	Gm. Mols. KCl per Liter.	Gms. K <sub>2</sub> PtCl <sub>6</sub> per 100 Gms. Solvent.	Gm. Mols. NaCl per Liter.	Gms. K <sub>2</sub> PtCl <sub>6</sub> per 100 Gms. Solvent.	Gm. Mols. NaCl per Liter.
0	0.4784	0.20	0.0236	0	0.0072	0
10	0.5992	0.25	0.0207	0.05	0.0070	0.05
20	0.7742	0.50	0.0109	0.10	0.0072	0.10
30	1	1	0.0046	0.25	0.0075	0.25
40	1.355	2	0.0045	0.50	0.0077	0.50
60	2.444	3	0.0043	0.75	0.0079	0.75
80	3.711	4	0.0042	1	0.0080	1
100	5.030	sat.	0.0034	2	0.834	2

## SOLUBILITY OF POTASSIUM CHLOROPLATINATE IN AQUEOUS SOLUTIONS OF METHYL ALCOHOL AND OF ETHYL ALCOHOL AT 20°.

(Archibald, Wilcox and Buckley, 1908.)

Wt. Per cent Alcohol in Solvent.	Gms. K <sub>2</sub> PtCl <sub>6</sub> per 100 Gms.:		Wt. Per cent Alcohol in Solvent.	Gms. K <sub>2</sub> PtCl <sub>6</sub> per 100 Gms.:	
	Aq. CH <sub>3</sub> OH.	Aq. C <sub>2</sub> H <sub>5</sub> OH.		Aq. CH <sub>3</sub> OH.	Aq. C <sub>2</sub> H <sub>5</sub> OH.
0	0.7742	0.7742	50	0.0625	0.0491
5	0.535	0.491	60	0.0325	0.0265
10	0.412	0.372	70	0.0182	0.0128
20	0.264	0.218	80	0.0124	0.0085
30	0.1831	0.134	90	0.0038	0.0025
40	0.1165	0.076	100	0.0027	0.0009

100 gms. aq. 8.2% isobutyl alcohol dissolve 0.625 gm. K<sub>2</sub>PtCl<sub>6</sub> at 20°.

100 gms. aq. sat. isobutyl alcohol dissolve 0.318 gm. K<sub>2</sub>PtCl<sub>6</sub> at 20°.

(Archibald, Wilcox and Buckley, 1908.)

One liter of 55% alcohol dissolves 0.150 gm. (NH<sub>4</sub>)<sub>2</sub>PtCl<sub>6</sub> at 15–20°. (Fresenius, 1846.)

" 76% " " 0.067 " " " "

" 95% " " 0.0037 " " " "



TRIBUTION OF PLATINUM CHLORIDE BETWEEN WATER AND ETHER AT  
ORD. TEMP. (Mylus, 1911.)

When 1 gm. of platinum as chloride is dissolved in 100 cc. of aq. 10% HCl and with 100 cc. of ether, 0.01 per cent of the platinum enters the ethereal layer. If ether is used instead of 10% HCl, approximately the same per cent of Pt enters the ether layer.

100 cc. anhydrous hydrazine dissolve 1 gm. platinum chloride, with formation of a precipitate at room temp. (Welsh and Broderson, 1915.)

**PLATINATES** of Hydrocarbon Sulfines.

SOLUBILITY OF EACH IN WATER AT 16°. (Strömholm, 1900.)

Name.	Formula.	Gms. Salt per 100 Gms. Sat. Solution.
Diethyl Sulfine Chloroplatinate	$[(CH_3)_2S]_2PtCl_6$	0.47
Diethyl Ethyl Sulfine Chloroplatinate	$[(CH_3)_2(C_2H_5)S]_2PtCl_6$	3.43
Diethyl Diethyl Sulfine Chloroplatinate	$[CH_3(C_2H_5)_2S]_2PtCl_6$	2.42
Diethyl Sulfine Chloroplatinate	$[(C_2H_5)_2S]_2PtCl_6$	1.98

Larger results for more complex sulfines are also given.

**PLATINO AMINES.**

SOLUBILITY IN WATER. (Cleve, 1866 ?)

Amine.	Formula.	Gms. per 100 Gms. H <sub>2</sub> O.
Platino Semi Diamine Chloride	$Pt < \begin{smallmatrix} (NH_3)_2 \\ Cl \end{smallmatrix} Cl$	0.26 at 0°, 3.4 at 100°
Platino Amine Chloride	$Cl_2Pt < \begin{smallmatrix} NH_3Cl \\ NH_3Cl \end{smallmatrix}$	0.14 at 0°, 3 at 100°
Platino Semi Diamine Chloride	$Cl_2Pt(NH_3)_2Cl$	0.33 at 0°, 1.54 at 100°

**PLATINOUS NITRITE AMMONIUM COMPOUNDS.**

SOLUBILITY IN WATER. (Tschugaeff and Kiltinovic, 1916.)

When ammonia is added to a cold solution of potassium platinonitrite a copious precipitate of the composition  $Pt_2NH_3(NO_2)_4$  is obtained. By comparison of the solubility of this precipitate with that of each of three hitherto described platinous compounds, it was found that the precipitate obtained as described

corresponds to the *cis* form of dinitro diammonio platinum,  $\begin{matrix} NH_3 \\ \diagup \\ Pt \\ \diagdown \\ NH_3 \end{matrix} < \begin{matrix} NO_2 \\ \diagup \\ \\ \diagdown \\ NO_2 \end{matrix}$

Results for the solubility of *cis* and *trans* dinitro diammonio platinum and of ammonium platinous platinonitrite in water, are as follows:

Gms. Each Compound per 100 Gms. H <sub>2</sub> O.			
t°.	<i>cis</i> $Pt_2NH_3(NO_2)_4$ .	<i>trans</i> $Pt_2NH_3(NO_2)_4$ .	$[Pt_4NH_3][Pt(NO_2)_4]$ .
25	0.083	0.063	0.011
63	0.66	0.49	...
74.4	...	0.81	...
95	2.32	1.85	...

Comparisons of the solubility of several mixtures of the *cis* and *trans* compounds in water are also given.

**PLATINOUS SULFONIC ACID (Free Acid)  $C_{10}H_7N:N.C_{10}H_4(OH)(SO_3H)_2.9H_2O$ .**

SOLUBILITY IN SEVERAL SOLVENTS AT 23°. (Sisley, 1902.)

Solvent.	Gms. Ponceau per Liter.
Water	209.6
" + 5 Gms. H <sub>2</sub> SO <sub>4</sub> per Liter	180
" Sat. with Amyl Alcohol	195
Amyl Alcohol	73.4
Ether, pure	none

Results are also given for the distribution of ponceau between water and amyl at 18°.



# POTASSIUM

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## POTASSIUM $K_2$ .

SOLUBILITY OF POTASSIUM IN LIQUID AMMONIA. (Ruff and Geisel, 1906.)

t°.	Mols. $NH_3$ to Dissolve 1 Gm. Atom K.
-100	4.82
-50	4.79
0	4.74

SOLUBILITY OF POTASSIUM IN MELTED KOH. (von Hevesy, 1909.)

Difficulty was experienced due to the failure of the excess of K to separate completely from the saturated solution. Time of heating, 50 hours.

t°.	Gms. K per 100 Gms. KOH.
480	7.8-8.9
600	3 -4
650	2 -2.7
700	0.5-1.3

## POTASAMMONIUM $K_2(NH_3)_2$ .

100 gms. liquid ammonia dissolve 99.5 gms.  $K_2(NH_3)_2$  at 0° and 97 gms. at +8.44°. (Joannis, 1906.)

## POTASSIUM ACETATE $CH_3COOK \cdot 1\frac{1}{2}H_2O$ .

SOLUBILITY IN WATER. (Abe, 1911.)

t°.	Gms. $CH_3COOK$ per 100 Gms. $H_2O$ .	Solid Phase.	t°.	Gms. $CH_3COOK$ per 100 Gms. $H_2O$ .	Solid Phase.
0.1	216.7	$2CH_3COOK \cdot 3H_2O$	41	327.7	$2CH_3COOK \cdot 3H_2O$
5	223.9	"	41.3	tr. pt.	" $+2CH_3COOK \cdot H_2O$
10	233.9	"	42	329	$2CH_3COOK \cdot H_2O$
15	243.1	"	45	332.2	"
20	255.6	"	50	337.3	"
25	269.4	"	60	350	"
30	283.8	"	70	364.8	"
35	301.8	"	80	380.1	"
38	314.2	"	90	396.3	"
40	323.3	"	96	406.5	"

SOLUBILITY OF POTASSIUM ACETATE IN Aq. ALCOHOL SOLUTIONS AT 25°. (Seidell, '10.)

Wt. % $C_2H_5OH$ in Solvent.	$d_{25}$ of Sat. Sol.	Gms. $CH_3COOK$ per 100 Gms. Solvent.	Wt. % $C_2H_5OH$ in Solvent.	$d_{25}$ of Sat. Sol.	Gms. $CH_3COOK$ per 100 Gms. Solvent.
0	1.417	219.6	70	1.156	118.3
20	1.363	219.6	80	1.085	87.6
40	1.302	192.4	90	0.990	52.9
50	1.260	171.8	95	0.922	34.2
60	1.210	147.5	100	0.850	16.3

F-pt. data for potassium acetate + acetic acid (Vasilev, 1909); potassium acetate + sodium acetate (Baskov, 1915).

## POTASSIUM SulfoANTIMONATE $K_3SbS_4 \cdot 5H_2O$ .

SOLUBILITY IN WATER. (Donk, 1908.)

t°.	Gms. $K_3SbS_4$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $K_3SbS_4$ per 100 Gms. Sat. Sol.	Solid Phase.
-1.3	9.5	Ice	-34	62	Ice + $K_3SbS_4 \cdot 6H_2O$
-2.6	17.1	"	-10	65.5	$K_3SbS_4 \cdot 6H_2O$
-4	24.2	"	-4.5	69.1	"
-7.2	35.4	"	0	75.4	$K_3SbS_4 \cdot 5H_2O$
-10.6	42.9	"	+10	76.2	"
-13.5	48.8	"	30	75.1	"
-18.5	52.6	"	50	77.7	$K_3SbS_4 \cdot 3H_2O$
-28.8	59.6	"	80	79.2	"



501 **POTASSIUM SulfoANTIMONATE****SOLUBILITY OF POTASSIUM SULFOANTIMONATE IN AQ. SOLUTIONS OF POTASSIUM HYDROXIDE AT 30° AND VICE VERSA.**  
(Donk, 1908.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$K_3SbS_4$	KOH.		$K_3SbS_4$	KOH.	
75	0	$K_3SbS_4 \cdot 5H_2O$	19.8	40.5	$K_3SbS_4$
68.4	3.4	$K_3SbS_4 \cdot 3H_2O$	11.5	49.9	" + $KOH \cdot 2H_2O$
56.8	11	"	9.4	49.9	$KOH \cdot 2H_2O$
50.9	16.1	$K_3SbS_4$	0	56.3	"
37.7	25.5	"			

**SOLUBILITY OF POTASSIUM SULFOANTIMONATE IN AQ. ETHYL ALCOHOL.**  
(Donk, 1908.)

Results at 10°.			Results at 30°.		
Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$K_3SbS_4$	$C_2H_5OH$		$K_3SbS_4$	$C_2H_5OH$	
0	94	$K_3SbS_4 \cdot 5H_2O$	0	97	$K_3SbS_4 \cdot 3H_2O$
0	90.5	"			
Two Liquid Layers Formed Here.			Two Liquid Layers Formed Here.		
69.2	0.8	"	75.1	0	"
76.1	0	"			

**Composition of the Liquid Layers.**

Gms. per 100 Gms.			
Alcoholic Layer.		Aqueous Layer.	
$K_3SbS_4$	$C_2H_5OH$	$K_3SbS_4$	$C_2H_5OH$
0	85	67.4	1.1
2.2	54.7	49	3.4
4.2	46.9	45.6	3.8
27.4	16	...	...
...	...	12.7	31.1

**Composition of the Liquid Layers.**

Gms. per 100 Gms.			
Alcoholic Layer.		Aqueous Layer.	
$K_3SbS_4$	$C_2H_5OH$	$K_3SbS_4$	$C_2H_5OH$
0	93.1	70.5	$\pm 0.5$
0	85.6	65.2	1.2
2.2	56.8	47.8	5.7
8.5	41.1	37.1	9.2

**SOLUBILITY OF POTASSIUM SULFOANTIMONATE IN AQ. METHYL ALCOHOL AT 15°.**  
(Donk, 1908.)**Composition of the Liquid Layers.**  
Gms. per 100 Gms.

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Alcoholic Layer.		Aqueous Layer.	
$K_3SbS_4$	$CH_3OH$		$K_3SbS_4$	$CH_3OH$	$K_3SbS_4$	$CH_3OH$
0.5	99.5	$K_3SbS_4$	5	82.5	62.5	8
0.45	99.5	"	4.9	76.3	...	...
1.5	93.9	"	7	66.9	...	...
1.8	92	"	13.6	54	...	...
Two Liquid Layers Formed Here.			19.1	45.5	...	...
62.7	7.5	$K_3SbS_4 \cdot 9H_2O$	...	...	31.1	31.3
68.4	3.5	"	...	...	41.1	22.2
75.5	0	"	...	...	47.2	18.2
Two Liquid Layers Formed Here.			...	...	57.2	11.1
0.5	98.1	"				

**POTASSIUM (Dihydrogen) ARSENATE**  $KH_2AsO_4$ .

1. 100 gms. sat. aq. solution contain 15.9 gms.  $KH_2AsO_4$ , or 100 gms.  $H_2O$  dissolve  
 2. 100 gms. at 6°. Sp. Gr. of solution = 1.1134. (Field, 1859.)  
 3. 100 gms. sat. aq. solution contain 28.24 gms.  $KH_2AsO_4$  at about 7°. (Muthmann and Kuntze, 1894.)  
 4. 100 gms. glycerol ( $d_{15} = 1.256$ ) dissolve 50.1 gms. potassium arsenate at 15–16°. (Ossendowski, 1907.)



**POTASSIUM BENZOATE**

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**POTASSIUM BENZOATE**  $\text{KC}_7\text{H}_5\text{O}_2 \cdot 3\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Pajetta, 1906, 1907.)

$t^\circ$ .	17.5°	25°	33.3
Gms. $\text{KC}_7\text{H}_5\text{O}_2$ per 100 Gms. Solution	41.1	42.4	44

**POTASSIUM BORATES.**

## SOLUBILITY OF POTASSIUM BORATES IN WATER AT 3

(Dukelski—Z. anorg. Chem. 50, 42, '06, complete references given.)

Gms. per 100 Gms. Solution.		Gms. per 100 Gms. Residue.		Solid Phase.
$\text{K}_2\text{O}$ .	$\text{B}_2\text{O}_3$ .	$\text{K}_2\text{O}$ .	$\text{B}_2\text{O}_3$ .	
47.50	...	...	...	$\text{KOH} \cdot \text{H}_2\text{O}$
46.36	0.91	46.13	9.02	$\text{K}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot 2\frac{1}{2}\text{H}_2\text{O}$
40.51	1.25	41.62	9.71	"
36.82	1.80	39.90	13.19	"
32.74	3.51	37.22	14.58	"
29.63	6.98	35.05	17.92	"
24.84	17.63	30.02	21.70	"
23.30	18.19	26.84	31.49	$\text{K}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$
16.21	13.10	25.12	33.18	"
11.78	9.82	20.57	26.43	"
9.18	8.00	22.38	31.30	"
6.22	9.13	20.87	31.06	"
7.73	13.37	22.21	36.24	$\text{K}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot 4\text{H}_2\text{O} + \text{K}_2\text{O}$
7.81	13.28	17.50	34.18	"
7.71	13.21	11.49	34.81	$\text{K}_2\text{O} \cdot 5\text{B}_2\text{O}_3 \cdot 8\text{H}_2\text{O}$
7.63	13.28	12.51	40.52	"
3.42	7.59	10.77	37.35	"
1.80	4.15	5.88	20.00	"
0.51	3.19	10.81	40.89	"
0.33	4.58	7.72	34.21	$\text{K}_2\text{O} \cdot 5\text{B}_2\text{O}_3 \cdot 8\text{H}_2\text{O}$
0.31	4.46	3.91	30.68	"
...	3.54	...	...	"

**POTASSIUM MetaBORATE**  $\text{KBO}_3$ .

Fusion-point data for potassium metaborate + sodium metapotassium metaborate + potassium metaphosphate are given b (1910-11).

**POTASSIUM PerBORATES**,  $2\text{KBO}_3 \cdot \text{H}_2\text{O}$ ,  $2\text{KBO}_3 \cdot \text{H}_2\text{O}_2$ .

## SOLUBILITY OF EACH IN WATER.

(v. Girsawald and Wolokitin, 1909.)

Borate.	% Active O in Borate.	$t^\circ$ .	Gms. Salt Gms. V
$2\text{KBO}_3 \cdot \text{H}_2\text{O}$	14.93	0	1.
"	14.93	15	2.
$2\text{KBO}_3 \cdot \text{H}_2\text{O}_2$	20.84	15	0.

**POTASSIUM (Fluo) BORIDE**  $\text{KBF}_4$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 0.44 gm.  $\text{KBF}_4$  at  $20^\circ$ , and 6.27 gr



**POTASSIUM BROMATE  $\text{KBrO}_3$ .****SOLUBILITY IN WATER.**(Kremers — Pogg. Ann. 97, 5, '56; Rammelsberg — *Ibid.* 55, 79, '42; Pohl — Sitzber. Akad. Wiss. Wien. 6, 595, '51.)

t°.	Gms. $\text{KBrO}_3$ per 100 Gms.		t°.	Gms. $\text{KBrO}_3$ per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	3.1	3.0	40	13.2	11.7
10	4.8	4.6	50	17.5	14.9
20	6.9	6.5	60	22.7	18.5
25	8.0	7.4	80	34.0	25.4
30	9.5	8.7	100	50.0	33.3

Sp. Gr. of solution saturated at 19.5° = 1.05.

**SOLUBILITY OF POTASSIUM BROMATE IN AQUEOUS SOLUTIONS OF SODIUM NITRATE AND OF SODIUM CHLORIDE.**

(Geffcken — Z. physik. Chem. 49, 296, '04.)

**In Sodium Nitrate.**

Grams per Liter.		Mols. $\text{KBrO}_3$ per Liter.
$\text{NaNO}_3$	$\text{KBrO}_3$	
0 - 0	78.79	0.4715
42 - 54	96.01	0.5745
85 - 09	108.6	0.6497
170 - 18	128.3	0.7680
255 - 27	150.9	0.9026
340 - 36	172.3	1.031

**In Sodium Chloride.**

Grams per Liter.		Mols. $\text{KBrO}_3$ per Liter.
$\text{NaCl}$	$\text{KBrO}_3$	
0.0	78.79	0.4715
29.25	82.24	0.5220
58.50	93.87	0.5616
117.0	100.9	0.6042
175.5	104.3	0.6244
234.0	106.9	0.6400

**SOLUBILITY OF POTASSIUM BROMATE IN AQUEOUS SOLUTIONS OF VARIOUS COMPOUNDS AT 25°.**

(Rothmund, 1910.)

Solvent, 0.5 Normal Aq. Sol. of:	Mols. $\text{KBrO}_3$ per Liter.	Gms. $\text{KBrO}_3$ per Liter.	Solvent, 0.5 Normal Aq. Sol. of:	Mols. $\text{KBrO}_3$ per Liter.	Gms. $\text{KBrO}_3$ per Liter.
Water alone	0.478	79.84	Dimethylpyrone	0.478	79.84
Methyl Alcohol	0.444	74.16	Ammonia	0.445	74.33
Ethyl Alcohol	0.421	70.33	Dimethylamine	0.384	64.13
Propyl Alcohol	0.409	68.31	Pyridine	0.415	69.31
Tertiary Amyl Alcohol	0.383	63.97	Piperidine	0.396	66.15
Acetone	0.425	70.99	Urethan	0.433	72.33
Ethyl Ether	0.395	65.98	Formamide	0.473	79.02
Formaldehyde	0.397	66.31	Acetamide	0.445	74.33
Glycol	0.448	74.84	Glycocol	0.501	83.68
Glycerol	0.451	75.34	Acetic Acid	0.456	76.17
Mannitol	0.451	75.34	Phenol	0.426	71.15
Grape Sugar	0.431	71.99	Methylal	0.405	67.66
Urea	0.477	79.68	Methyl Acetate	0.420	70.15



# POTASSIUM BROMIDE

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## POTASSIUM BROMIDE KBr.

### SOLUBILITY IN WATER.

(Average curve from results of Meusser — Z. anorg. Chem. 44, 79, '05; Etard — Compt. rend. 98, 1432, '84; Ann. chim. phys. [7] 2, 526, '94; de Coppet — *Ibid.* [5] 30, 116, '83; Tilden and Shenstone — Phil. Trans. 173, 23, '84.)

t°.	Grams KBr per 100 Grams		t°.	Grams KBr per 100 Grams	
	Solution.	Water.		Solution.	Water.
— 6.5	20.0	25.0	30	41.4	70.6
— 8.5	26.5	35.7	40	43.0	75.5
— 10.5	29.5	41.8	50	44.5	80.2
— 11.5	31.2	45.3	60	46.1	85.5
— 10	31.8	46.7	70	47.4	90.0
— 5	33.3	50.0	80	48.7	95.0
0	34.9	53.5	90	49.8	99.2
5	36.1	56.5	100	51.0	104.0
10	37.3	59.5	110	52.3	109.5
15	38.5	62.5	140	54.7	120.9
20	39.5	65.2	181	59.3	145.6
25	40.4	67.7			

### SOLUBILITY OF MIXTURES OF POTASSIUM BROMIDE AND AMMONIUM BROMIDE IN WATER AT 25°.

(Fock — Z. Kryst. Min. 28, 357, '97.)

Grams per Liter Solution.		Mol. per cent in Solution.		Sp. Gr. of Solutions.	Mol. per cent in Solid Phase	
NH <sub>4</sub> Br.	KBr.	NH <sub>4</sub> Br.	KBr.		NH <sub>4</sub> Br.	KBr.
0.00	558.1	0.0	100	1.3756	0.00	100
6.4	554.2	1.38	98.62	1.3745	0.26	99.74
24.64	536.5	5.29	94.71	1.3733	1.27	98.73
51.34	516.8	10.77	89.23	1.3721	3.02	96.98
152.9	441.2	29.63	70.37	1.3711	8.42	91.58
262.2	347.3	47.84	52.16	1.3715	17.20	82.80
347.6	262.3	61.69	38.31	1.3753	27.98	72.02
381.4	260.3	64.03	35.97	1.3753	32.53	67.47
417.8	232.2	68.61	31.39	1.3766	39.45	60.55
432.5	222.3	70.27	29.73	1.3777	variable	variable
480.8	179.9	76.47	23.53	1.3766	98.53	1.47
577.3	0.0	100.0	0.0	1.3763	100.0	0.00

### SOLUBILITY OF POTASSIUM BROMIDE AT 25° IN:

Aq. Solutions of KCl and Vice Versa.

(Amadori and Pampanini, 1911.)

Gms. per 100 Gms. H <sub>2</sub> O.	
KBr.	KCl.
68.47	0
62.26	5.43
58.50	8.46
52.45	12.48
45.42	17.17
38.70	21.23
26.62	25.88
12.94	31.02
0	36.12

Aq. Solutions of KI and Vice Versa.

(Amadori and Pampanini, 1911.)

Gms. per 100 Gms. H <sub>2</sub> O.	
KBr.	KI.
53.21	35.92
42.32	66.63
34.14	95.36
30.08	119.52
29.62	119
22.15	127.10
21.88	127.31
18.54	130.61
0	149.26

(See also next page.)



**SOLUBILITY OF POTASSIUM BROMIDE IN AQUEOUS SOLUTIONS OF POTASSIUM HYDROXIDE.**

(Ditte — *Compt. rend.* 124, 30, '97.)

Grams per 1000 Grams H <sub>2</sub> O.		Grams per 1000 Grams H <sub>2</sub> O.	
KOH.	KBr.	KOH.	KBr.
36.4	558.4	277.6	248.1
113.5	433.6	434.7	137.1
177.2	358.1	579.6	64.8
231.1	281.2	806.9	33.4

**SOLUBILITY OF MIXTURES OF POTASSIUM BROMIDE AND CHLORIDE AND OF MIXTURES OF POTASSIUM BROMIDE AND IODIDE IN WATER.**

(Etard — *Ann. chim. phys.* [7] 3, 275, '97.)

**Mixtures of KBr and KCl.**

**Mixtures of KBr and KI.**

°.	Grams per 100 Gms. Solution.		Grams per 100 Grams Solution.	
	KBr.	KCl.	KBr.	KI.
-20	17.5	10.5	9.2	42.5
0	21.5	10.8	9.9	45.3
10	23.2	11.0	10.2	46.6
20	24.8	11.2	10.5	47.5
25	25.5	11.3	10.7	48.0
30	26.3	11.4	10.9	48.6
40	28.0	11.5	11.2	49.6
60	30.6	11.8	11.9	51.3
80	33.4	12.1	12.6	52.7
100	35.7	12.6	13.2	53.8
120	38.0	12.9	14.0	54.8
150	40.6	13.4	14.9	55.5

**SOLUBILITY OF POTASSIUM BROMIDE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE, AND OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM BROMIDE, AT 25.2°.**

(Touren — *Compt. rend.* 130, 1252, '00.)

**KBr in Aq. KCl Solutions.**

**KCl in Aq. KBr Solutions.**

Mols. per Liter.		Grams per Liter.		Mols. per Liter.		Grams per Liter.	
KCl.	KBr.	KCl.	KBr.	KBr.	KCl.	KBr.	KCl.
0.0	4.761	0.0	567.0	0.0	4.18	0.00	311.8
0.67	4.22	50.0	502.5	0.40	3.85	58.4	287.2
0.81	4.15	60.4	494.2	0.85	3.58	101.3	267.1
1.35	3.70	100.7	440.7	1.31	3.19	156.1	238.0
1.48	3.54	110.4	421.6	1.78	2.91	211.9	217.1
1.61	3.42	120.0	407.2	2.25	2.58	268.0	192.4
1.70	3.34	126.8	397.7	2.69	2.33	320.4	173.8
2.46	2.50	183.5	297.7				
3.775	0.525	281.6	625.3				



SOLUBILITY OF POTASSIUM BROMIDE IN AQUEOUS SOLUTIONS OF POTASSIUM NITRATE, AND OF POTASSIUM NITRATE IN AQUEOUS SOLUTIONS OF POTASSIUM BROMIDE, AT 14.5° AND AT 25°  
(Touren — Compt. rend. 130, 908, '00.)

KBr in Aqueous KNO <sub>3</sub> Solutions.				KNO <sub>3</sub> in Aq. KBr			
Mols. per Liter.		Grams per Liter.		Mols. per Liter.		Grams per Liter.	
KNO <sub>3</sub> .	KBr.	KNO <sub>3</sub> .	KBr.	KBr.	KNO <sub>3</sub> .	KBr.	Gm. KBr.
Results at 14.5°.				Results at 14.50°.			
0.0	4.332	0.0	515.9	0.0	2.228	0	0
0.362	4.156	36.6	494.9	0.356	2.026	42	42
0.706	4.093	71.4	487.4	0.784	1.835	93	93
1.235	3.939	124.9	469.1	1.092	1.730	130	130
				1.577	1.587	187	187
Results at 25°.				2.542	1.406	302	302
0.0	4.761	0.0	566.2	3.536	1.308	421	421
0.131	4.72	13.3	561.0	Results at 25°.			
0.527	4.61	53.3	549.1	0.0	3.217	0	0
0.721	4.54	72.9	540.8	0.38	3.026	45	45
1.09	4.475	110.3	533.0	0.93	2.689	110	110
1.170	4.44	118.4	528.8	1.37	2.492	165	165
1.504	4.375	152.2	521.1	1.208	2.216	145	145
				2.87	1.958	345	345
				3.55	1.807	425	425

SOLUBILITY OF POTASSIUM BROMIDE IN ALCOHOLS

(de Bruyn — Z. physik. Chem. 10, 783, '92; Rohland — Z. anorg. Chem. 1, 1, '97.)

Alcohol.	Grams KBr Dissolved by 100 Gms. Alcohol	
	Room Temp. (R.).	25° (de Bruyn)
Methyl Alcohol	1.92	1.51 Abs
Ethyl Alcohol	0.28 (Sp. Gr. 0.81)	0.13
Propyl Alcohol	0.055	...

SOLUBILITY OF POTASSIUM BROMIDE IN AQUEOUS SOLUTIONS OF POTASSIUM NITRATE

(Taylor — J. Physic. Ch. 1, 724, '96-'97.)

Wt. per cent Alcohol in Solution.	Results at 30°.		Results at 25°.	
	Gms. KBr per 100 Gms. Sat. Solution.	Gms. KBr per 100 Gms. Solvent.	Gms. KBr per 100 Gms. Sat. Solution.	Gms. KBr per 100 Gms. Solvent.
0	41.62	71.30	43.40	71.30
5	38.98	67.25	40.85	67.25
10	36.33	63.40	38.37	63.40
20	31.09	56.40	33.27	56.40
30	25.98	50.15	28.32	50.15
40	21.24	44.95	23.22	44.95
50	16.27	38.85	18.11	38.85
60	11.50	32.50	13.02	32.50
70	6.90	24.70	7.98	24.70
80	3.09	15.95	3.65	15.95
90	0.87	8.80	1.03	8.80

100 gm. acetone dissolve 0.023 gm. KBr at 25°.

(Krug and McElroy — J. anal. Chem. 1, 1, '97.)



## SOLUBILITY OF POTASSIUM BROMIDE IN DILUTE AQUEOUS ETHYL ALCOHOL.

Results at 0°.

(Armstrong, Eyre, Hussey and Paddison, 1907.)

Results at 25°.

(Armstrong, Eyre, Hussey and Paddison, 1907.)

I	Gms. KBr per 100 Gms. Sat. Sol.	Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	Gms. KBr per 100 Gms. Sat. Sol.	$d_{4}^{25}$ of Sat. Sol.
	34.92	0	40.78	1.3824
	34.35	1.14	39.98	1.3727
	32.96	2.25	39.54	1.3634
	31.99	4.41	38.41	1.3443
	29.43	12.14	34.97	1.2815
		18.73	30.91	1.2322

Methyl alcohol dissolve 2.17 gms. KBr at 25°. (Turner and Bissett, 1913.)

ethyl	"	0.142 gm.	"	"	"
propyl	"	0.035 "	"	"	"
amyl	"	0.003 "	"	"	"

## SOLUBILITY OF POTASSIUM BROMIDE IN AQUEOUS SOLUTIONS OF METHYL ALCOHOL AT 25°.

(Hers and Anders, 1907.)

Gms. KBr per 100 cc. Sat. Sol.	$d_{4}^{25}$ of Sat. Sol.	Wt. % CH <sub>3</sub> OH in Solvent.	Gms. KBr per 100 cc. Sat. Sol.	$d_{4}^{25}$ of Sat. Sol.
56.04	1.3797	64	10.35	0.9801
46.28	1.300	78.1	5.24	0.8906
29.98	1.159	98.9	2.74	0.8411
19.28	1.058	100	1.69	0.8047

Solubility of potassium bromide in methyl alcohol at the critical temperature by Centnerszner (1910), as 0.2 gm. KBr per 100 gms. sat solution.

15% formic acid dissolve 23.2 gms. KBr at 18.5°. (Aschan, 1913.)

hydrous hydrazine dissolve 60 gms. KBr at room temp.

(Welsh and Broderson, 1915.)

hydroxylamine dissolve about 44.7 gms. KBr at 17°-18°.

(de Bruyn, 1892.)

## SOLUBILITY OF POTASSIUM BROMIDE AT 25° IN:

(Hers and Knoch, 1905.)

Aqueous Acetone.				Aqueous Glycerol.			
Per 100 cc. Sat. Solution.			Sp. Gr. Solutions.	KBr per 100 cc. Sol.			Sp. Gr. Solutions.
Millimols. KBr.	Gms. KBr.	Gms. H <sub>2</sub> O.		Wt. % Glycerol in Solvent.	Millimols.	Gms.	
1.3	57.3	80.6	1.3793	0	481.3	57.32	1.3793
6.7	43.67	69.5	1.2688	13.28	444.3	52.91	1.3704
0.5	36.98	62.97	1.2118	25.98	404	48.11	1.3655
9	30.85	55.60	1.1558	45.36	340.5	40.55	1.3594
2.9	24.16	47.60	1.0918	54.23	310.4	36.98	1.3580
4.9	17.22	39.15	1.0275	83.84	219.25	26.11	1.3603
5.3	11.35	29.78	0.9591	100	172.65	20.56	1.3691
6.5	5.54	20.10	0.8942				
0.1	1.20	10.15	0.8340				

A solution of potassium bromide in furfural (C<sub>4</sub>H<sub>3</sub>O<sub>2</sub>COH) contains 3r at 25°. (Walden, 1906.)

## N-POINT DATA FOR MIXTURES OF KBr AND OTHER SALTS.

CF	(Kurnakow and Wrzesnewsky, 1912; Ruff and Plato, 1903.)
CCl	(Wrzesnewsky, 1912; Amadori and Pampanini, 1911; Ruff and Plato 1903.)
Cl	" " " " " "
AgBr	(Sandonnini, 1912.)
NaCl	(Ruff and Plato, 1903.)
COH	(Scarpa, 1915.)



# POTASSIUM BUTYRATE

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## POTASSIUM BUTYRATE $C_4H_7COOK$ .

100 gms. water dissolve 296.8 gms.  $C_4H_7COOK$ , or 100 gms. sat. solution contain 74.8 gms. at  $31.25^\circ$ .

100 gms. of an aq. solution saturated with sugar and  $C_4H_7COOK$  contain 49.19 gms. sugar + 34.78 gms.  $C_4H_7COOK$  + 16.03 gms.  $H_2O$  at  $31.25^\circ$ .

(Köhler, 1897.)

## POTASSIUM CAMPHORATES.

SOLUBILITY IN AQUEOUS SOLUTIONS OF *d* CAMPHORIC ACID AT  $13.5-16^\circ$  AND VICE VERSA.

(Jungfleisch and Landrien, 1914.)

Gms. per 100	Gms. Sat. Sol.	Solid Phase.	Gms. per 100	Gms. Sat. Sol.	Solid Phase.
$C_9H_{14}(COOH)_2$ .	$C_{10}H_{16}O_4K_2$ .		$C_9H_{14}(COOH)_2$ .	$C_{10}H_{16}O_4K_2$ .	
0	66.65	$C_{10}H_{16}O_4K_2$	2.90	32.84	$C_{10}H_{16}O_4K_2.C_9H_{14}O$
0.90	69.69	$C_{10}H_{16}O_4K$	3.20	29.39	"
1	69	"	3.30	28.56	$C_{10}H_{16}O_4K_2.C_9H_{14}O$
1.10	66.79	"	3.20	27.32	"
0.90	66.65	$C_{10}H_{16}O_4K.H_2O$	3.20	22.77	"
1.50	62.37	"	3.10	21.66	"
2.60	59.34	"	2.90	12.97	"
3.20	58.37	"	2.90	11.73	"
3.20	58.09	"	3.10	11.59	$dC_9H_{14}(COOH)_2$
3.20	52.71	$C_{10}H_{16}O_4K.C_{10}H_{16}O_4$	2.90	9.66	"
3.20	48.43	"	2.80	8.14	"
2.80	47.88	"	2.50	6.76	"
2.80	42.36	"	2.30	6.07	"
3	35.60	"	2	4.55	"
2.85	34.77	"	0.621	0	"

$C_{10}H_{16}O_4K_2$  = Dipotassium *d* camphorate.  $C_{10}H_{16}O_4K.C_9H_{14}O$  = Monopotassium *d* dicamphorate.  
 $C_{10}H_{16}O_4K$  = Monopotassium *d* camphorate.  $C_{10}H_{16}O_4K_2.C_{10}H_{16}O_4$  = Monopotassium *d* tetracamphorate.

## POTASSIUM CARBONATE $K_2CO_3.2H_2O$ .

SOLUBILITY IN WATER.

(de Coppet, 1872; Meyerhoffer, 1905; Osaka, 1910-12; Kremann and Zitek, 1909; de Waal, 1910; Mulder, 1864.)

t°.	Gms. $K_2CO_3$ per 100 Gms. Sat. Solution.	Solid Phase.	t°.	Gms. $K_2CO_3$ per 100 Gms. Sat. Solution.	Solid Phase.
-10	21.3	Ice	40	53.9	$K_2CO_3.2H_2O$
-20	31	"	50	54.8	"
-30	36.9	"	60	55.9	"
-36.5 Eutec.	39.6	" + $K_2CO_3.H_2O$	70	57.1	"
-6.8 tr. pt.	50.9	$K_2CO_3.H_2O + K_2CO_3.2H_2O$	80	58.3	"
0	51.3	$K_2CO_3.2H_2O$	90	59.6	"
+10	52	"	100	60.9	"
20	52.5	"	110	62.5	"
25	52.8	"	120	64.4	"
30	53.2	"	130	66.2	"

Single determinations, not in good agreement with the above, are given by Köhler (1897), by Engel (1888), and by Greenish and Smith (1901).

## POTASSIUM BiCARBONATE $KHCO_3$ .

SOLUBILITY IN  $H_2O$ . (Dibbets, 1874.)

t°.	0	10	20	30	40
Gms. $KHCO_3$ per 100 Gms. Sat. Sol.	18.3	21.7	24.9	28.1	31.2

100 gms. sat. aqueous solution contain 18.7 gms.  $KHCO_3$  at  $0^\circ$  (*d* = (Engel, 1888); 23.7 gms  $KHCO_3$  at  $15^\circ$  (Greenish & Smith, 1901); 26.3 gr. = 20° (de Forcrand, 1909).



TABLE I. SOLUBILITY OF POTASSIUM BICARBONATE IN AQUEOUS SOLUTIONS OF POTASSIUM CARBONATE AT 0°. (Engel, 1888.)

Mols. per 1 cc. Solution.		Sp. Gr. of Solutions.	Grams per 100 cc. Solution.	
CO <sub>2</sub>	KHCO <sub>3</sub>		K <sub>2</sub> CO <sub>3</sub>	KHCO <sub>3</sub>
0.0	21.15	1.133	0.0	21.2
0.14	15.28	1.182	11.8	15.3
0.10	12.65	1.20	16.7	12.6
0.50	10.25	1.241	23.8	10.3
0.20	7.55	1.298	34.0	7.6
0.14	5.86	1.350	43.0	5.9
0.60	4.90	1.398	51.6	4.9
0.50	3.75	1.448	60.5	3.8
0.75	0.0	1.542	81.4	0.0

TABLE II. SOLUBILITY OF POTASSIUM CARBONATE IN AQUEOUS SOLUTIONS OF POTASSIUM HYDROXIDE AND OF POTASSIUM HYDROXIDE AT 30°. (de Waal, 1910.)

Gms. per 100 Gms. Sat. Sol.		Results for K <sub>2</sub> CO <sub>3</sub> + KOH.	
KCl.	Solid Phase.	K <sub>2</sub> CO <sub>3</sub> .	KOH.
0	K <sub>2</sub> CO <sub>3</sub> ·1½H <sub>2</sub> O	53.27	0
1.03	" + KCl	2.50	53.77
1.07	KCl	2.05	55.14
26.22	"	0	55.75
28.01	"		

10 dissolve 10.76 gms. K<sub>2</sub>CO<sub>3</sub> + 2.66 gms. KNO<sub>3</sub> at 10° when both are present in excess. (Kremann and Zitek, 1909.)

10 dissolve 10.53 gms. K<sub>2</sub>CO<sub>3</sub> + 6.12 gms. Na<sub>2</sub>CO<sub>3</sub> at 10° when present in excess (Kremann and Zitek, 1909). See also Potassium carbonate, p. 512.

Aqueous solutions of K<sub>2</sub>CO<sub>3</sub> + KNO<sub>3</sub> + Na<sub>2</sub>CO<sub>3</sub> + NaNO<sub>3</sub>, simulated with two or more of the salts at 10° and at 25°, are also given by Kremann and Zitek (1909).

The reciprocal salt pairs K<sub>2</sub>CO<sub>3</sub> + BaSO<sub>4</sub> ⇌ K<sub>2</sub>SO<sub>4</sub> + BaCO<sub>3</sub> at 25°, are given by Meyerhoffer (1905).

A solution, simultaneously saturated with K<sub>2</sub>CO<sub>3</sub>·2H<sub>2</sub>O, K<sub>2</sub>SO<sub>4</sub> and KNO<sub>3</sub> dissolves 53.1 gms. K<sub>2</sub>CO<sub>3</sub> + 0.023 gm. K<sub>2</sub>SO<sub>4</sub> at 25°. (Meyerhoffer, 1905.)

TABLE III. SOLUBILITY OF POTASSIUM CARBONATE, ETHYL ALCOHOL AND WATER AT 23°-26°. (Frankforter and Frary, 1913.)

The binodal curve for the system (see note, p. 287) was very irregular and tie lines were located by estimations of K<sub>2</sub>CO<sub>3</sub> in specially conjugated liquids. The original results have been plotted and data for the conjugated layers read from the curve:

Rich Layer (Upper)		Water Rich Layer (Lower.)		
per 100 Gms. Solution.		Gms. per 100 Gms. Solution.		
C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	K <sub>2</sub> CO <sub>3</sub> .	C <sub>2</sub> H <sub>5</sub> .	H <sub>2</sub> O.
90.65	9.255†	53.6	0.28	46.12†
72.7	27.059	39.11	1	59.89
53.5	44.78	29.62	4	66.38
42.6	53.37	25.7	6.4	67.9
35.5	58.2	21.08	11	67.92
31	60.71	19.15	13.2	67.65
27	62.65	18.18	14.7	67.12
20.5	65.3	14.2	20.5	65.3*

\* Plait point.

† Quad. point.

These give a complete summary of previous investigations of this system (1899, 1900); Bell (1905); Cuno (1908-09).



POTASSIUM CARBONATE 510

Data for the conjugated liquid layers obtained in the system potassium carbonate, ethyl alcohol and water at 17° and at 35° are given by de Bruyn (1900) and at 20°, 40° and 60° by Cuno (1908).

COMPOSITION OF THE CONJUGATED LIQUIDS WHICH ARE IN EQUILIBRIUM WITH SOLID POTASSIUM CARBONATE (QUADRUPLE POINTS) AT VARIOUS TEMPERATURES.

t°.	Gms. per 100 Gms. Upper Layer.			Gms. per 100 Gms. Lower Layer.		
	K <sub>2</sub> CO <sub>3</sub> .	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	K <sub>2</sub> CO <sub>3</sub> .	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.
-18	0.03	90.3	9.7	51.2	0.2	48.6
0	0.04	91.9	8.1	51.3	0.2	48.5
+17	0.06	91.5	8.4	52.1	0.2	47.7
35	0.07	90.9	9	53.4	0.2	46.4
50	0.09	91.8	8.1	55.3	0.2	44.5
75	0.12	91.4	8.5	57.9	0.2	41.9

EQUILIBRIUM IN THE SYSTEM POTASSIUM CARBONATE, METHYL ALCOHOL AND WATER AT 23°-26°. (Frankforter and Frary, 1913.)

The authors give the data for the binodal curve and the quadruple point but tie lines, other than for the quadruple points, were not determined.

Gms. per 100 Gms. Homogeneous Liquid.			Gms. per 100 Gms. Homogeneous Liquid.		
K <sub>2</sub> CO <sub>3</sub> .	CH <sub>3</sub> OH.	H <sub>2</sub> O.	K <sub>2</sub> CO <sub>3</sub> .	CH <sub>3</sub> OH.	H <sub>2</sub> O.
6.32	75.85	17.83*	21.61	33.43	44
6.91	63.13	29.97	23.15	31.26	45
8.07	59.26	32.67	28.25	23.82	47
10.17	52.64	35.33	30.72	20.57	48
12.03	49.97	37.99	32.92	17.27	49
14.24	45.74	40.02	40.65	9.26	50
16.48	41.76	41.76	43.95	6.96	49
18.89	37.76	43.36	45.89	6.42	47
			49.05	6.1	44

\* Upper quad. point. † Lower quad. point.

The following results for the solubility of K<sub>2</sub>CO<sub>3</sub> in concentrations CH<sub>3</sub>OH above and below those yielding liquid layers are also given.

Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.	
CH <sub>3</sub> OH.	K <sub>2</sub> CO <sub>3</sub> .	CH <sub>3</sub> OH.	K <sub>2</sub> CO <sub>3</sub> .
1.03	51.39	85	2.05
2.22	50.33	89.2	1.56
6.1	49.05 (Lower quad. pt.)	91	1.98
Two Liquid Layers Formed Here.		93.6	2.72
75.85	6.32 (Upper quad pt.)	94.3	5.7 (Abs. CH <sub>3</sub> OH)

Data for the binodal curves for this system at 17° and at 35° are given by de Bruyn (1900).

This author also gives the following data for the composition of the conjugated liquids in equilibrium with solid potassium carbonate (quadruple point) at various temperatures.

t°.	Gms. per 100 Gms. Upper Layer.			Gms. per 100 Gms. Lower Layer.		
	K <sub>2</sub> CO <sub>3</sub> .	CH <sub>3</sub> OH.	H <sub>2</sub> O.	K <sub>2</sub> CO <sub>3</sub> .	CH <sub>3</sub> OH.	H <sub>2</sub> O.
-30	21.7	42.2	36.1	...	...	...
-20	13.8	52.1	34.1	...	...	...
-20	12.4	...	...	44.2	8.2	47
0	7.6	66.3	26.1	46.3	6.7	47
0	7.4	...	...	46.6	6.6	46
+17	6.2	69.6	24.2	48.3	5.7	46
35	5	72.9	22.1	51	4.3	44



**II. IN THE SYSTEM POTASSIUM CARBONATE, NORMAL PROPYL ALCOHOL AND WATER AT 22°–26°.**  
(Frankforter and Frary, 1913.)

rs give the data for the binodal curve and the quadruple points were not located.

100 Gms. Homogeneous Liquid.		Gms. per 100 Gms. Homogeneous Liquid.		
$C_2H_5OH.$	$H_2O.$	$K_2CO_3.$	$C_2H_5OH.$	$H_2O.$
0.02	47.08*	7.45	9.30	83.25
0.12	52.91	5.97	11.07	82.96
0.20	60.80	4.73	12.71	82.56
0.20	65.15	3.86	14.60	81.54
0.45	69.12	3.11	17.17	79.71
0.78	72.71	2.42	24.71	72.87
1.32	75.87	1.91	34.90	63.19
2.31	78.62	1.71	39.	59.29
3.24	80.41	1.33	45.57	53.09
4.41	82.12	0.948	51.56	47.49
6.24	82.77	0.387	64.20	35.41
8.31	83.14	0.017	95.83	4.153†

\* Lower quad. point.

† Upper quad. point.

**III. IN THE SYSTEM POTASSIUM CARBONATE, ISOPROPYL ALCOHOL AND WATER AT 20°.**  
(Frankforter and Temple, 1915.)

The results for the binodal curve in this and the following system are in terms of gms. per 100 gms. solvent (water + alcohol) instead of gms. of homogeneous liquid ( $K_2CO_3$  + water + alcohol.)

100 Gms. Alcohol + Water.		Gms. per 100 Gms. Alcohol + Water.		
Alcohol.	Water.	$K_2CO_3.$	Alcohol.	Water.
2.911	97.089	15.021	19.445	80.555
4.783	95.217	13.244	23.919	76.081
7.349	92.651	6.065	45.397	54.603
9.159	90.841	3.933	53.265	46.735
14.395	85.605	2.954	57.294	42.706

**IV. IN THE SYSTEM POTASSIUM CARBONATE, ALLYL ALCOHOL AND WATER AT 20°.**  
(Frankforter and Temple, 1915.)

100 Gms. Alcohol + Water.		Gms. per 100 Gms. Alcohol + Water.		
Alcohol.	Water.	$K_2CO_3.$	Alcohol.	Water.
2.103	97.897	8.239	30.677	69.323
5.267	94.733	5.521	39.337	60.663
9.309	90.691	2.020	54.487	45.513
15.037	84.963	1.015	62.610	37.390
22.454	77.546	0.0853	81.228	18.772

**V. IN THE SYSTEM POTASSIUM CARBONATE, ACETONE, WATER AT 20°.**  
(Frankforter and Cohen, 1914.)

The binodal curve was very carefully determined and, in addition, data for the tie lines (solid  $K_2CO_3$ ) and five tie lines were located. These data were the following interpolated values for the conjugated liquids read from the phase diagram.

100 Gms. Upper Layer.		Gms. per 100 Gms. Lower Layer.		
$(CH_3)_2CO.$	$H_2O.$	$K_2CO_3.$	$(CH_3)_2CO.$	$H_2O.$
96.4	3.5+†	52.4	trace	47.6†
64	35.96	32.63	1.2	66.17
55.3	43.99	24.4	3.7	71.9
48.5	50.14	22.91	4.7	72.39
34	61.43	16.92	10.2	72.88
27.5	65.53	14.77	13	72.23
20	69.5*	10.5	20	69.5

\* Plait point.

† Quad. points.



# POTASSIUM CARBONATE

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## EQUILIBRIUM IN THE SYSTEM POTASSIUM CARBONATE, POTASSIUM MALONATE AND WATER AT 25°.

(M'David, 1909-10.)

A series of mixtures of  $K_2CO_3 + KC_{11}H_{11}O_4 + H_2O$  were prepared and mixed. They were placed in a thermostat at 25° and the two layers separated in each case, were analyzed.

Gms. per 100 Gms. Upper Layer.			Gms. per 100 Gms. Lower Layer.	
$K_2CO_3$	$KC_{11}H_{11}O_4$	$H_2O$	$K_2CO_3$	$KC_{11}H_{11}O_4$
4.05	65.1	30.85	42.6	0.4
4.9	59.8	35.3	40.7	0.4
5.6	53.5	40.9	35	0.5
7.2	50.5	42.3	33.5	0.9
8.7	39.2	52.1	28.0	0.7
11	34.6	54.4	26.8	0.8
14.5	23.5	62	24.8	3
17	18.6	64.4	23.1	6.05
18.6	15	66.4	21.7	8.7

Several determinations at 2° and at 56° are also given.

100 cc. anhydrous hydrazine dissolve 1 gm.  $K_2CO_3$  at room temp.

100 gms. aqueous solution simultaneously sat. with  $K_2CO_3$  and 31.25° contain 22.24 gms.  $K_2CO_3$  and 56 gms. sugar.

Freezing-point data for mixtures of  $K_2CO_3 + KCl$  and  $K_2CO_3 + Na_2CO_3$  (Le Chatelier, 1894).

# POTASSIUM SODIUM CARBONATE $K_2CO_3 \cdot Na_2CO_3 \cdot 12H_2O$ .

## SOLUBILITY IN WATER AT 25°.

(Osaka, 1910-11.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.	
$K_2CO_3$	$Na_2CO_3$		$K_2CO_3$	$Na_2CO_3$
52.83	0	$K_2CO_3 \cdot 2H_2O$	25.2	14.1
52	1	"	22.4	16.6
50.7	2.6	"	19.8	18.7
49.1	4.6	" + $K_2CO_3 \cdot Na_2CO_3 \cdot 12H_2O$	19.1	19.7
49	4.6	$K_2CO_3 \cdot Na_2CO_3 \cdot 12H_2O$	15.1	23.2
46.5	4.3	"	14.5	22.8
46.2	5.2	"	10.8	22.7
41	6.3	"	10.7	22.4
37.7	7	"	4.7	21.9
31	10.5	"	0	22.71

The previous determinations of Kremann and Zitek (1909), agree with the above, but these authors report that the double salt crystallizes instead of  $12H_2O$ .

100 gms.  $H_2O$  dissolve 184 gms. potassium sodium carbonate at 15°.

# POTASSIUM URANYL CARBONATE $2K_2CO_3 \cdot (UO_2)_2CO_3$ .

100 gms.  $H_2O$  dissolve 7.4 gms. salt at 15°.

# POTASSIUM CHLORATE $KClO_3$ .

## SOLUBILITY IN WATER.

Average curve from results of Carlson (1910), Calzolari (1912), and Tschugueff and

t°.	d of Sat. Sol.	Gms. $KClO_3$ per 100 Gms. $H_2O$ .	t°.	d of Sat. Sol.
0	1.021	3.3	40	1.073
10	...	5	50	...
15	...	6.1	60	1.115
20	1.045	7.4	80	1.165
25	...	8.8	100	1.219
30	...	10.5	104 b. pt.	1.230

For previous results in good agreement with the above, see next page.



**POTASSIUM CHLORATE**  $\text{KClO}_3$ . (See also previous page.)**SOLUBILITY IN WATER.**

(Gay-Lussac, 1819; Pawlewski, 1899; above 100°, Tilden and Shenstone, 1881; see also Blarez, 1891; Etard, 1894; at 99°, Köhler, 1879.)

t°.	Gms. KClO <sub>3</sub> per 100 Gms.			t°.	Gms. KClO <sub>3</sub> per 100 Gms.		
	Solution.	Water.			Solution.	Water.	
0	3.04	3.14	3.3*	70	22.55	29.16	32.5*
10	4.27	4.45	5.0	80	26.97	36.93	39.6
20	6.76	7.22	7.1	90	31.36	46.11	47.5
35	7.56	8.17	8.6	100	35.83	55.54	56.0
40	8.46	9.26	10.1	120	42.4	73.7	73.7
50	11.75	13.31	14.5	136	49.7	98.5	99.0
60	15.18	17.95	19.7	190	64.6	183.0	183.0
70	18.97	23.42	26.0	330	96.7	2930.00	...

\* Gay Lussac.

100 gms.  $\text{H}_2\text{O}$  dissolve 5.06 gms.  $\text{KClO}_3$  at 10°.

(Roozeboom, 1891.)

1 liter of  $\text{H}_2\text{O}$  dissolves 65.5 gms.  $\text{KClO}_3$  at about 20°.

(Konowalow, 1899b.)

1 liter of 5.2%  $\text{NH}_3$  solution dissolves 52.5 gms.  $\text{KClO}_3$  at about 20°. "**SOLUBILITY OF POTASSIUM CHLORATE IN AQUEOUS SOLUTIONS OF POTASSIUM PEROXIDE, HYDROGEN PEROXIDE, AND MIXTURES OF THE TWO AT 25°.**

(Calvert, 1901.)

The mixtures were agitated by means of a stream of air. Equilibrium was reached both from above and below 25°.

Composition of Solvent.				Mols. $\text{KClO}_3$ Dissolved per Liter of Sat. Sol.	Gms. $\text{KClO}_3$ Dissolved per Liter of Sat. Sol.
Water alone				0.675	82.71
Aqueous 0.125 % KOH				0.625	76.60
" 0.25 % "				0.573	70.23
Aq. $\text{H}_2\text{O}_2$ containing 1.26 mols. $\text{H}_2\text{O}_2$ per l.				0.730	89.45
" " 1.31 " "				0.737	90.33
Aq. 0.25 % KOH " 0.015 " "				0.578	70.82
" " 0.276 " "				0.584	71.57
" " 0.954 " "				0.616	75.50
" " 1.073 " "				0.673	82.47

**SOLUBILITY OF POTASSIUM CHLORATE IN AQUEOUS SOLUTIONS OF POTASSIUM BROMIDE AT 13°.** (Blarez, 1911.)

Gms. per 100 Gms. Solution.		Gms. per 100 Gms. Solution.		Gms. per 100 Gms. Solution.	
KBr.	$\text{KClO}_3$ .	KBr.	$\text{KClO}_3$ .	KBr.	$\text{KClO}_3$ .
0.20	5.18	1.0	5.04	6.0	3.46
0.60	5.20	2.0	4.60	8.0	2.80
0.8	5.06	3.0	4.2	10.0	2.40
		4.0	4.0		

**SOLUBILITY OF POTASSIUM CHLORATE IN AQUEOUS SOLUTIONS OF OTHER POTASSIUM SALTS AT 14°-15°.** (Blarez, 1911.)

Salt.	Gms. per 100 Gms. Solution.		Salt.	Gms. per 100 Gms. Solution.	
	K Salt.	$\text{KClO}_3$ .		K Salt.	$\text{KClO}_3$ .
KOH	1.43	4.47	$\text{KNO}_3$	2.59	4.51
KCl	1.91	4.45	"	5.18	3.88
"	3.82	3.58	$\text{K}_2\text{SO}_4$	2.23	4.71
KBr	3.05	4.49	"	4.46	3.98
"	6.10	3.60	$\text{K}_2\text{C}_2\text{O}_4$	2.42	4.72
KI	4.25	4.59	"	4.85	3.93
"	8.51	3.65			



# POTASSIUM CHLORATE

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## SOLUBILITY OF POTASSIUM CHLORATE IN AQUEOUS SOLUTIONS POTASSIUM CHLORIDE AT 20°.

(Winteler — Z. Electrochem. 7, 360, '00.)

Sp. Gr. of Solutions.	Grams per Liter.		Sp. Gr. of Solutions.	Grams per Liter.	
	KCl.	KClO <sub>3</sub> .		KCl.	KClO <sub>3</sub> .
1.050	0	71.1	1.098	120	24.5
1.050	10	58.0	1.108	140	22.5
1.050	20	49.0	1.119	160	21.0
1.054	40	39.5	1.130	180	20.0
1.064	60	34.0	1.140	200	20.0
1.075	80	30.0	1.168	250	20.0
1.086	100	27.0			

## SOLUBILITY OF POTASSIUM CHLORATE IN AQUEOUS SOLUTIONS POTASSIUM NITRATE.

(Arrhenius — Z. physik. Chem. 12, 397, '93.)

Results at 19.85°.

Results at 23.87°.

Mols. per Liter.		Grams per Liter.		Mols. per Liter.		Grams per Liter.	
KNO <sub>3</sub> .	KClO <sub>3</sub> .	KNO <sub>3</sub> .	KClO <sub>3</sub> .	KNO <sub>3</sub> .	KClO <sub>3</sub> .	KNO <sub>3</sub> .	KClO <sub>3</sub> .
0.0	0.570	0.0	69.88	0.0	0.645	0.0	79.0
0.125	0.529	12.65	64.86	0.5	0.515	50.59	63.0
0.25	0.492	25.29	60.33				
1.0	0.374	101.19	45.85				
2.0	0.328	202.38	40.22				

## SOLUBILITY OF POTASSIUM CHLORATE: (Taylor, 1897; see also Gerardin, 1865.)

In Aqueous Alcohol.

In Aqueous Acetone.

Wt. per cent Alcohol or of Acetone in Solvent.	At 30°.		At 40°.			At 30°.		At 40°.	
	Gms. KClO <sub>3</sub> per 100 Gms. Solution.	Water.	Gms. KClO <sub>3</sub> per 100 Gms. Solution.	Water.		Gms. KClO <sub>3</sub> per 100 Gms. Solution.	Water.	Gms. KClO <sub>3</sub> per 100 Gms. Solution.	Water.
0	9.23	10.17	12.23	13.93		9.23	10.17	12.23	13.93
5	7.72	8.80	10.48	12.33		8.32	9.56	11.10	13.11
10	6.44	7.65	8.84	10.77		7.63*	9.09	10.28*	12.60
20	4.51	5.90	6.40	8.56		6.09	8.10	8.27	11.26
30	3.21	4.74	4.67	7.00		4.93	7.40	6.69	10.24
40	2.35	4.00	3.41	5.88		3.90	6.76	5.36	9.45
50	1.64	3.33	2.41	4.94		2.90	5.98	4.03	8.40
60	1.01	2.53	1.41	3.69		2.03	5.17	2.86	7.35
70	0.54	1.82	0.78	2.63		1.24	4.18	1.68	5.68
80	0.24	1.22	0.34	1.73		0.57	2.88	0.79	3.97
90	0.06	0.62	0.12	1.17		0.18	1.82	0.24	2.45

\* Solvent, 9.09 Wt. per cent Acetone.

100 gms. sat. solution of KClO<sub>3</sub> in glycol contain 0.9 gms. KClO<sub>3</sub>.  
(de Coninck, 1905.)



**SOLUBILITY OF POTASSIUM CHLORATE IN AQUEOUS SOLUTIONS OF VARIOUS COMPOUNDS AT 25°.** (Rothmund, 1910.)

Aqueous 0.5 Normal Solution of:	KClO <sub>3</sub> per Liter.		Aqueous 0.5 Normal Solution of:	KClO <sub>3</sub> per Liter.	
	Mols.	Gms.		Mols.	Gms.
Water alone	0.1475	20.44	Ammonia	0.1474	20.43
Methyl Alcohol	0.1402	19.43	Dimethylamine	0.1342	18.60
Ethyl Alcohol	0.1356	18.75	Pyridine	0.1410	19.54
Propyl Alcohol	0.1343	18.61	Urethan	0.1400	19.40
Tertiary Amyl Alcohol	0.1279	17.72	Formamide	0.1539	21.32
Acetone	0.1451	20.11	Acetamide	0.1447	20.05
Ether	0.1336	18.51	Acetic Acid	0.1462	20.26
Glycol	0.1416	19.62	Phenol	0.1362	18.87
Glycerol	0.1404	19.45	Methylal	0.1400	19.40
Urea	0.1510	20.92	Methyl Acetate	0.1429	19.80

100 gms. glycerol ( $d_{15} = 1.256$ ) dissolve 3.54 gms. KClO<sub>3</sub> at 15–16°. (Ossendowski, 1907.)

**POTASSIUM PERCHLORATE KClO<sub>4</sub>.**

**SOLUBILITY IN WATER.**

(Average curve from results of Noyes and Sammet (1903); Carlson (1910); Rosenheim and Weinhaber (190–11); Cabolari (1912); Thin and Cumming (1915).)

t°.	d of Sat. Sol.	Gms. KClO <sub>4</sub> per 100 Gms. H <sub>2</sub> O.	t°.	d of Sat. Sol.	Gms. KClO <sub>4</sub> per 100 Gms. Sat. Sol.
0	1.007	0.75	50	...	6.5
10	...	1.05	60	1.033	9
20	1.011	1.80	70	...	11.8
25	1.012	2.08	80	1.053	14.8
30	...	2.6	90	...	18
40	1.022	4.4	100	1.067	21.8

**SOLUBILITY OF POTASSIUM PERCHLORATE IN AQUEOUS AND IN ALCOHOLIC SOLUTIONS OF PERCHLORIC ACID AT 25.2°.**

(Thin and Cumming, 1915.)

**In Aq. HClO<sub>4</sub> Solutions.**

Normality of Aq. HClO <sub>4</sub> .	Gms. KClO <sub>4</sub> per 100 Gms. Sat. Sol.
0 (= water)	2.085
0.01	1.999
0.10	1.485
1	0.527

**In Alcoholic HClO<sub>4</sub> Solutions.**

Aqueous Solvent.	Gms. KClO <sub>4</sub> per 100 Gms. Sat. Sol.
93.5% Alcohol	0.051
+ 0.2% HClO <sub>4</sub> *	0.0175
98.8% Alcohol +	0.010
+ 2% HClO <sub>4</sub> *	0.028

\* The HClO<sub>4</sub> was added as aq. 20% HClO<sub>4</sub> solution hence the concentration of the alcohol was decreased.

**SOLUBILITY OF POTASSIUM PERCHLORATE IN Aq. KCl AND Aq. K<sub>2</sub>SO<sub>4</sub> SOLUTIONS AT 25°.** (Noyes and Boggs, 1911.)

**In Aq. KCl Solutions.**

Gms. per 100.2 cc. Sat. Sol.		
KClO <sub>4</sub>	KCl	
2.0566	0	...
1.7800	0.3715	101.42
1.5597	0.7421	101.45

**In Aq. K<sub>2</sub>SO<sub>4</sub> Solutions.**

Gms. per 100.2 cc. Sat. Sol.		
KClO <sub>4</sub>	K <sub>2</sub> SO <sub>4</sub>	
2.0566	0	...
1.8262	0.4339	101.47
1.6396	0.8665	101.55

100 gms. 51.2 Vol. % Aq. C<sub>2</sub>H<sub>5</sub>OH ( $d = 0.9319$ ) dissolve 0.754 gm. KClO<sub>4</sub> at 25.2°.

" 93.5 " " ( $d = 0.8219$ ) " 0.051 gm. KClO<sub>4</sub> at 25.2°.

" 98.8 " " ( $d = 0.7998$ ) " 0.019 gm. KClO<sub>4</sub> at 25.2°.

" 90 Wt. % Aq. C<sub>2</sub>H<sub>5</sub>OH " 0.036 gm. KClO<sub>4</sub> at 25.2°.

" 97.2 " " " 0.0156 gm. KClO<sub>4</sub> at 25.2°.

(Wenze, 1891.)



# POTASSIUM CHLORIDE

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## POTASSIUM CHLORIDE KCl.

### SOLUBILITY IN WATER.

(Average curve from the results of Meusser — Z. anorg. Chem. 44, 70, '05; at 31.25°, Köhler — Z. Ver. Zuckerind. 47, 447, '07; Andrae — J. pr. Chem. [2] 20, 456, '84; Gerardin — Ann. chim. phys. [4] 5, 137, '65; de Coppet *Ibid.* [5] 30, 411, '83; Etard *Ibid.* [7] 2, 526, '94; Mulder; above 100°, Tilden and Shenstone — Proc. Roy. Soc. (Lond.) 35, 345, '83.)

t°	Gms. KCl per 100 Gms.		t°	Gms. KCl per 100 Gms.		t°	Gms. KCl per 100 Gms.	
	Solution.	Water.		Solution.	Water.		Solution.	Water.
-9	19.3	23.9	40	28.6	40.0	147	41.5	70.8
-4.5	20.6	25.9	50	29.9	42.6	180	43.7	77.5
0	21.6	27.6	60	31.3	45.5	Solid Phase Ice		
5	22.7	29.3	70	32.6	48.3	-9	19.3	23.9
10	23.7	31.0	80	33.8	51.1	-8.	17.7	21.5
15	24.5	32.4	90	35.1	54.0	-8	16.7	20.0
20	25.4	34.0	100	36.2	56.7	-7	14.9	17.5
25	26.2	35.5	130	39.8	66.0	-6	13.6	15.7
30	27.1	37.0				-5.5	12.5	14.3

Sp. Gr. of solution sat. at 0° = 1.150; at 15° = 1.172.

The following determinations of the solubility of potassium chloride in water, made with exceptional care, are reported by Berkeley (1904).

t°.	d of Sat. Sol.	Gms. KCl per 100 Gms. H <sub>2</sub> O.	t°.	d of Sat. Sol.	Gms. KCl per 100 Gms. H <sub>2</sub> O.
0.70	1.1540	28.29	74.80	1.2032	49.58
19.55	1.1738	34.37	89.45	1.2069	53.38
32.80	1.1839	38.32	108 (b. pt.)	1.2118	58.11
59.85	1.1980	45.84			

100 gms. H<sub>2</sub>O dissolve 36.12 gms. KCl at 25°. (Amadori and Pampanini, 1911.)

F.-pt. data for aq. KCl solutions are given by Roloff (1895).

Data for equilibrium in the system potassium chloride, arsenic trioxide and water at 30° are given by Schreinemakers and de Baat (1915).

### SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 0° AND AT 25°.

(Armstrong, Eyre, Hussey and Paddinson, 1907; Armstrong and Eyre, 1910-11.)

Solvent, Gms. HCl per 1000 Gms. H <sub>2</sub> O.	Gms. KCl per 100 Gms. Sat. Sol.	
	At 0°.	At 25°.
0	22.11	26.45
9.11	20.93	25.17
18.22	19.71	24.07
36.45	17.26	21.74
109.35	...	13.47
182.25	...	6.93

### SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROBROMIC ACID AND OF HYDROCHLORIC ACID AT 25°. (Herz, 1911-12.)

In Aq. HBr.

In Aq. HCl.

Millimols per 10 cc.		Gms. per Liter.		Millimols per 10 cc.		Gms. per Liter.	
HBr.	KCl.	HBr.	KCl.	HCl.	KCl.	HCl.	KCl.
0	42.72	0	318.5	5.66	37.49	20.64	279
6.61	37.80	53.5	281.9	10.20	33.79	37.19	252
34.15	19.57	276.4	146	15.91	28.68	57.98	213
				20.94	24.74	76.35	146
				32.52	17.39	118.6	129



**SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 0°.**

(Jeannel — Compt. rend. 103, 381, '86; Engel — Ann. chim. phys. [6] 13, 377, '88.)

Milligram Mols. per 10 cc.		Grams per 100 cc. Solution.		Sp. Gr. of Solutions.
KCl.	HCl.	KCl.	HCl.	
34.5	0.0	25.73	0.0	1.159
30.41	3.9	22.69	1.42	1.152
27.95	6.6	20.84	2.41	1.150
27.5	7.1	20.51	2.59	1.147
23.75	11.1	17.71	4.05	1.137
16.0	23.0	11.93	8.39	1.111
10.0	34.0	7.46	12.40	1.105
7.5	41.0	5.60	14.95	1.105
2.0	65.5	1.49	23.88	1.121
2.4	148.8 (sat.)	1.52	54.26	1.224

100 cc. saturated HCl solution dissolve 1.9 gms. KCl at 17°. (Ditte, 1881.)

100 gms. sat. aq. HCl solution dissolve 1.9 gms. KCl at 20°. (Stoltzenberg, 1912.)

F.-pt. data for mixtures of KCl and HCl are given by Dernby (1918).

**SOLUBILITY OF MIXTURES OF POTASSIUM CHLORIDE AND OF SODIUM CHLORIDE IN AQUEOUS HYDROCHLORIC ACID SOLUTIONS AT 25°.**

(Hicks, 1915.)

Gms. per 100 Gms. Sat. Solutions.		
HCl.	NaCl.	KCl.
0	19.95	10.90
8.61	10.65	7.58
17.16	3.56	3.80
20.65	2.03	2.86
32.78	0.18	1.27

**SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS MAGNESIUM CHLORIDE SOLUTIONS.**

(Precht and Wittgen — Ber. 14, 1667, '81.)

t°.	Grams KCl per 100 Grams Sat. Solution in:				
	11% MgCl <sub>2</sub> .	15% MgCl <sub>2</sub> .	21.2% MgCl <sub>2</sub> .	30% MgCl <sub>2</sub> .	20% MgCl <sub>2</sub> .
10	14.3	9.9	5.3	1.9	4.2 KCl + 5.7 NaC
20	15.9	11.3	6.5	2.6	6.0 " + 5.9 "
30	17.5	12.7	7.6	3.4	6.9 " + 6.0 "
40	19.0	14.2	8.8	4.2	7.9 " + 6.1 "
50	20.5	15.6	10.0	5.0	8.9 " + 6.3 "
60	21.9	17.0	11.2	5.8	9.9 " + 6.4 "
80	24.5	19.5	13.6	7.3	10.9 " + 6.6 "
90	25.8	20.8	14.7	8.1	11.9 " + 6.7 "
100	27.1	22.1	15.9	8.9	13.0 " + 6.9 "

More recent data on the solubility of potassium chloride in aqueous solutions of magnesium chloride are given by Feit and Przibylla (1909).



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SOLUBILITY OF MIXTURES OF POTASSIUM CHLORIDE AND POTASSIUM BROMIDE AT 25°.

(Fock, 1897.)

Grams per Liter Solution.		Milligram Mols. per Liter.		Mol. per cent KCl in Solution.	Sp. Gr. of Solutions.	Mol. K Solid.
KBr.	KCl.	KBr.	KCl.			
558.1	0.00	4686.2	0.0	0.0	1.3756	0
531.5	23.44	4462.7	314.2	6.16	1.3700	0
503.6	46.57	4228.5	624.3	12.86	1.3648	8
454.6	82.62	3817.8	1108.0	22.49	1.3544	15
379.6	136.6	3188.1	1830.7	36.48	1.3320	33
324.8	166.9	2727.6	2237.4	45.06	1.3119	63
218.0	213.9	1830.2	2868.0	60.30	1.2689	82
140.7	250.9	1181.1	3363.9	74.01	1.2455	88
47.5	291.7	398.8	3911.4	85.22	1.1977	96
0.0	311.3	0.0	4173.1	100.00	1.1756	100

SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS POTASSIUM HYDROXIDE SOLUTIONS.

(Engel — Bull. soc. chim. [3] 6, 16, '91; Winteler — Z. Electrochem. 7, 360, '00.)

Results at 0°.  
(Engel.)

Results at 20°.  
(Winteler.)

Mg. Mols. per 10 cc. Solution.		Sp. Gr. of Solution.	Gms. per 100 cc. Solution.		Gms. per 100 cc. Solution.		Sp. Gr. of Solution.
KCl.	KOH.		KCl.	KOH.	KCl.	KOH.	
35.5	0	1.159	26.83	0.0	29.3	1.0	1.18
31.0	2.375	1.146	23.44	1.33	21.1	10.0	1.22
28.3	4.7	1.153	21.39	2.64	14.8	20.0	1.24
23.0	9.9	1.172	17.39	5.56	10.4	30.0	1.26
18.38	15.1	1.195	13.89	8.46	6.8	40.0	1.30
14.43	20.0	1.216	10.91	11.23	4.0	50.0	1.33
11.43	24.63	1.239	8.64	13.83	2.2	60.0	1.40
8.98	29.25	1.261	6.78	16.43	1.4	70.0	1.50
6.28	35.13	1.294	4.74	19.72	1.1	80.0	1.55
					0.9	85.0	1.58

SOLUBILITY OF MIXTURES OF POTASSIUM CHLORIDE AND POTASSIUM IODIDE IN WATER.

(Etard — Ann. chim. phys. [7] 3, 275, '94.)

t°.	Grams per 100 Gms. Solution.		t°.	Grams per 100 Gms. Solution.	
	KCl.	KI.		KCl.	KI.
0	3.7	50.5	100	6.2	61.0
20	4.2	53.0	140	7.3	63.7
40	4.7	55.3	180	8.3	65.5
60	5.2	57.5	220	9.4	66.3
80	5.7	59.4	245	10.0	66.5



ABILITY OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM  
IODIDE AT 25° AND VICE VERSA.

(Amadori and Pampanini, 1911.)

Gms. per 100 Gms. H <sub>2</sub> O.		Gms. per 100 Gms. H <sub>2</sub> O.	
KCl.	KI.	KCl.	KI.
0	149.26	19.64	68.22
4.06	144.03	23.75	43.89
7.63	137.79	29.56	23.83
11.36	132.60	31.38	14.83
11.74	133.90	33.68	7
15.10	105.91	36.12	0

ABILITY OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM  
NITRATE AT 0° AND AT 25°.

(Armstrong and Eyre, 1910-11.)

Solvent, Gms. KNO <sub>3</sub> per 1000 Gms. H <sub>2</sub> O.	Gms. KCl Dissolved per 100 Gms. Sat. Solution at:	
	0°.	25°.
0	22.10	26.73
25.27	21.71	26.26
50.55	21.25	25.61
101.11	20.70	24.58
151.66	...	23.57

ABILITY DATA FOR THE RECIPROCAL SALT PAIRS  $\text{KCl} + \text{NaNO}_3 \rightleftharpoons \text{NaCl} + \text{KNO}_3$   
AT 5°, 25°, 50° AND 100°.

(Reinders, 1914, 1915; see also Uyeda, 1909-10.)

Results at 25°.				Results at 50°.				Solid Phase in Each Case.
Gms. per 100 Gms. H <sub>2</sub> O.				Gms. per 100 Gms. H <sub>2</sub> O.				
KCl.	NaNO <sub>3</sub> .	KNO <sub>3</sub> .		NaCl.	KCl.	NaNO <sub>3</sub> .	KNO <sub>3</sub> .	
...	...	...		36.72	...	...	...	NaCl
10	...	...		...	...	...	...	"
16.45	...	...		28.35	23.09	...	...	NaCl+KCl
26.78	...	...		...	42.80	...	...	KCl
35.54	...	10		...	41.39	...	24.05	"
34.92	...	22.79		...	38.75	...	52.54	KCl+KNO <sub>3</sub>
10	...	31.48		...	...	...	85.10	KNO <sub>3</sub>
...	10	37.49		...	...	...	...	"
...	60	41.87		...	...	...	...	"
...	100.9	46.15		...	...	134.9	90.2	KNO <sub>3</sub> +NaNO <sub>3</sub>
...	96.06	20		...	...	114.1	...	NaNO <sub>3</sub>
...	77.46	...		...	...	...	...	"
2	...	58.01		20.5	...	84.8	...	NaNO <sub>3</sub> +NaCl
0	...	10		28.4	...	43.9	...	NaCl
2	22.2	15.4		34	13.4	...	24.3	NaCl+KCl
6	20	...		12.7	25.4	...	58.6	KCl+KNO <sub>3</sub>
...	61.3	17.2		...	...	...	...	KNO <sub>3</sub> +NaNO <sub>3</sub>
...	82.1	43.15		19.2	...	104.1	27.2	NaNO <sub>3</sub> +NaCl
...	64	41.2		12.2	...	110.7	82.2	NaCl+NaNO <sub>3</sub> +KNO <sub>3</sub>
...	...	40.3		59.9	...	6.1	70.9	NaCl+KCl+KNO <sub>3</sub>
Results at 5°.				Results at 100°.				
10.4	...	...		27.3	36.2	...	...	NaCl+KCl
29.84	...	10.14		...	41.6	...	199	KCl+KNO <sub>3</sub>
...	82.10	18.1		...	...	233.6	218	KNO <sub>3</sub> +NaNO <sub>3</sub>
...	41.7	...		19.2	...	158	...	NaNO <sub>3</sub> +NaCl



SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM NITRATE, AND OF POTASSIUM NITRATE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE, AT SEVERAL TEMPERATURES.

(Touren, 1900; Bodländer, 1891; Nicol, 1891; Soch, 1898.)

KCl in Aq. KNO<sub>3</sub> Solutions at:

14.5° (T.).		25.2° (T.).		20°, etc. (N.).	
Gms. per Liter Solution.		Gms. per Liter Solution.		Gms. per 1000 Gms. H <sub>2</sub> O.	
KNO <sub>3</sub> .	KCl.	KNO <sub>3</sub> .	KCl.	KNO <sub>3</sub> .	KCl.
0	288.3	0	311.8	0	345.2
20.64	284.2	13.76	306.6	56.18	342.15
32.18	282.1	32.18	303.6	168.54	334.39
62.23	276.8	91.26	293.2	at 25° (S)	
82.77	273.5	122.7	287.2	225.8	341.3
115.9	270.7	141.4	284.2	at 80° (S)	
119.1	268.3	182.7	276	1175	402
123.4	267.2				

KNO<sub>3</sub> in Aq. KCl Solutions at:

14.5°.		25.2°.		20°.	
Gms. per Liter Solution.		Gms. per Liter Solution.		Gms. per 1000 Gms. H <sub>2</sub> O.	
KCl.	KNO <sub>3</sub> .	KCl.	KNO <sub>3</sub> .	KCl.	KNO <sub>3</sub> .
0	225.4	0	325.5	0	311.1
13.58	219.8	19.39	312.3	82.9	256.8
31.63	208.2	49.22	288.7	165.8	221.7
65.64	185.2	100.7	254	248.7	202
132.6	159.5	155.2	224.4	310.8	501.6
164.4	153.3	207.3	203.9		
196.5	144	226.8	196.9		
236.9	137.1				

In the case of the results by Touren, constant temperature and agitation were employed.

KNO<sub>3</sub> in Aq. KCl at 20.5° (B.).

Gms. per 100 cc. Solution.		Sp. Gr. of Solutions.
KCl.	KNO <sub>3</sub> .	
0	27.68	1.1625
4.72	24.39	1.1700
7.74	22.44	1.1765
12.23	20.23	1.1895
15.15	18.96	1.1983
19.61	17.67	1.2150
22.17	17.11	1.2265
24.96	16.79	1.2400

KCl in Aq. KNO<sub>3</sub> at 17.5° (B.).

Gms. per 100 cc. Solution.		Sp. Gr. of Solutions.
KNO <sub>3</sub> .	KCl.	
0	29.39	1.1730
6.58	27.50	1.1980
8.88	27.34	1.2100
12.48	26.53	1.2250
14.83	25.98	1.2360
15.22	25.96	1.2390
15.49	25.95	1.2388
15.33	26.24	1.2410

In the case of the above results by Bodländer, a saturated aqueous solution of potassium chloride was prepared and weighed amounts of potassium nitrate were added to measured volumes of it. The mixtures were warmed and then allowed to cool to the indicated temperature and frequently shaken during 24 hours.



OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM  
NITRATE AND VICE VERSA.

(Leather and Mukerji, 1913.)

alts at 30°.		Results at 40°.				Results at 91°.			
per 100 Gms. H <sub>2</sub> O.		Sp. Gr.		Gms. per 100 Gms. H <sub>2</sub> O.		Sp. Gr.		Gms. per 100 Gms. H <sub>2</sub> O.	
1.	KNO <sub>3</sub> .	Sat.	Sol.	KCl.	KNO <sub>3</sub> .	Sat.	Sol.	KCl.	KNO <sub>3</sub> .
58	0	1.194		40.60	0	1.222		53.58	0
72	8.05	1.252		39.11	16.86	1.344		47.85	52.75
19	19.36	1.305		37.08	35.45	1.486		43.30	114.6
42	26.83	1.319		37.49	39.71	1.552		39.90	162.9
71	29.19	1.312		32.22	41.52	1.544		33.25	165.6
35	32.34	1.297		22.63	46.31	1.545		15.56	181.1
44	38.10	1.279		11.58	52.66	1.552		0	202.8

Results are also given for 20°.

SOLUBILITY OF MIXTURES OF POTASSIUM CHLORIDE AND SODIUM  
CHLORIDE IN WATER.

Gms. per 100 Gms. H <sub>2</sub> O.		t°.	Gms. per 100 Gms. H <sub>2</sub> O.	
KCl.	NaCl.		KCl.	NaCl.
(1) 11.2(2)	30(1)	50	22(1)	19(2)
12.3	29.7	60	24.6	20.6
13.8	29.2	70	27.3	22.5
(3) 14.5	29(3)	80	31(3)	25.2(3)
15.4	28.7	90	32.9	28.4
17	28.2	100	34.7	32.3

Precht and Wittgen, 1881; (2) Etard, 1897; (3) at 25° and at 80°, Soch, 1898.

Page and Keightly, Rudorff and also Nicol give single determinations nearer the results of Precht and Wittgen than to those of Etard.

OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF SODIUM  
CHLORIDE AND VICE VERSA.

(Leather and Mukerji, 1913; see also Nicol, 1891.)

alts at 20°.		Results at 40°.				Results at 91°.			
per 100 Gms. H <sub>2</sub> O.		Sp. Gr.		Gms. per 100 Gms. H <sub>2</sub> O.		Sp. Gr.		Gms. per 100 Gms. H <sub>2</sub> O.	
1.	NaCl.	Sat.	Sol.	KCl.	NaCl.	Sat.	Sol.	KCl.	NaCl.
61	0	1.194		40.60	0	1.222		53.58	0
60	10.13	1.207		31.42	10.68	1.236		45.01	10.66
65	20.61	1.235		24.43	20.99	1.262		35.84	22.87
92	30.36	1.248		18.23	30.60	1.262		33.12	28.12
36	29.61	1.242		18.74	30.32	1.264		32.45	28.26
76	30.38	1.247		19.13	29.92	1.235		27.15	29.18
70	32.40	1.222		10.49	32.59	1.223		13	33.93
	35.63	1.197		0	36.53	1.189		0	38.72

Results are also given for 30°.

wt. per cent alcohol dissolve 5.87 gms. KCl + 12.25 gms. NaCl at 25°.  
wt. per cent alcohol dissolve 5.29 gms. KNO<sub>3</sub> + 10.06 gms. KCl at 25°.

(Soch, 1898.)

1. ethyl alcohol dissolve 0.034 gm. KCl at 18.5°.

2. methyl alcohol dissolve 0.5 gm. KCl at 18.5°.

(de Bruyn, 1892; Rohland, 1898.)



# POTASSIUM CHLORIDE

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## SOLUBILITY DATA FOR THE RECIPROCAL SALT PAIRS $\text{KCl} + \text{Na}_2\text{SO}_4 \rightleftharpoons \text{K}_2\text{SO}_4 + \text{NaCl}$ (Meyerhoffer and Saunders, 1899.)

t°.	d <sub>4</sub> of Sat. Sol.	Mols. per 1000 Mols. H <sub>2</sub> O.				Solid Phase.
		SO <sub>4</sub> .	K <sub>2</sub> .	Na <sub>2</sub> .	Cl <sub>2</sub> .	
4.4*	...	5.42	14.39	51.83	60.8	K <sub>2</sub> Na(SO <sub>4</sub> ) <sub>2</sub> + KCl.
0.2	...	3.35	12.78	50.93	60.36	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O + KC
0.4	...	3.59	16.38	40.75	53.54	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O + KCl +
16	...	4.72	17.58	50.56	63.42	K <sub>2</sub> Na(SO <sub>4</sub> ) <sub>2</sub> + KCl.
24.8	1.2484	4.37	20.02	48.36	64.01	"
16.3*	...	16.29	9.16	61.06	53.93	K <sub>2</sub> Na(SO <sub>4</sub> ) <sub>2</sub> + NaCl + Na <sub>2</sub> SO <sub>4</sub>
24.5	1.2625	14.45	9.90	58.46	53.91	K <sub>2</sub> Na(SO <sub>4</sub> ) <sub>2</sub> + NaCl
0.3	...	2.75	25.77	17.93	40.95	K <sub>2</sub> Na(SO <sub>4</sub> ) <sub>2</sub> + KCl
25	1.2034	2.94	36.20	14.80	48.06	"
17.9*	1.2470	13.84	0	62.54	48.70	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O + Na <sub>2</sub>
30.1*	1.289	50.41	10.08	40.33	0	K <sub>2</sub> Na(SO <sub>4</sub> ) <sub>2</sub> + Na <sub>2</sub> SO <sub>4</sub> ·10

tr. pt.

Curves are given in the original paper and a complete discussion of tl

## SOLUBILITY OF MIXTURES OF POTASSIUM CHLORIDE AND PO SULFATE IN WATER.

t°.	Gms. per 100 Gms. H <sub>2</sub> O.		Observer.	t°.	Gms. per 100 Gms	
	KCl	+ K <sub>2</sub> SO <sub>4</sub> .			KCl	+ K <sub>2</sub>
10	30.9	1.32	(Precht & Wittgen.)	40	38.7	1.
15.8	28	2.3	(Kopp.)	50	41.3	1.
20	33.4	1.43	(P. and W.)	60	43.8	1.
25	34.76	2.93	(Van't Hoff & Meyerhoffer.)	80	49.2	2.
30	36.1	1.57	(P. and W.)	100	54.5	2.

100 gms. aq. solution, sat. with both salts, contain 26.2 gms. KCl  
K<sub>2</sub>SO<sub>4</sub> at 30°.

(Schreinemakers an

## SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF CHLORIDE AT 25° AND VICE VERSA. (Fujimura, 1914.)

Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.	Gms. per 100 Gms. H <sub>2</sub> O.	
SnCl <sub>2</sub> .	KCl.		SnCl <sub>2</sub> .	KCl.
0	34.73	KCl	58.48	17.85
2.86	32.17	"	81.78	19.06
4.37	34.08	"	107.65	17.79
5.95	31.76	SnCl <sub>2</sub> ·2KCl·2H <sub>2</sub> O	170.70	21.26
5.83	30.65	"	247.50	24.38
10.24	27.30	"	337.26	25.51
17.42	24.68	"	290.30	19.66
27.88	24.40	"	235.50	7.49
34.28	5.99	"	222.5	2.73
54.19	19.45	SnCl <sub>2</sub> ·KCl·H <sub>2</sub> O	234.05	...

## SOLUBILITY OF POTASSIUM CHLORIDE IN DILUTE SOLUTIONS OF ALCOHOL AT 0° AND AT 25°.

(Armstrong, Eyre, Hussey and Paddison, 1907; Armstrong and Eyre, 1910-

Gms. KCl Dissolved per 100 Gms.

Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	Sat. Sol. at:		d <sub>4</sub> Sol. S
	0°.	25°.	
0	22.1	26.44	1.18
1.14	21.6	25.91	1.17
2.25	20.9	25.29	1.16
4.41	19.7	24.21	1.15
8.44	...	22.46	1.13
12.13	15.5	...	...
18.69	...	17.42	1.08



## SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS ALCOHOL.

(Gerardin — Ann. chim. phys. [4] 5, 140, '65.)

Interpolated from the original results.

Grams KCl per 100 Gms. Aq. Alcohol of Sp. Gr.:								
Sp. Gr.	0.9904 = 5.5	0.9848 = 9.35	0.9793 = 13.6	0.9736 = 19.1	0.9573 = 30	0.939 = 40	0.8967 = 60	0.8244 = 90
	Wt. %.	Wt. %.	Wt. %.	Wt. %.	Wt. %.	Wt. %.	Wt. %.	Wt. %.
23.4	19.5	15.5	11.5	7.0	4.0	1.7	0.0	
25.0	21.0	16.8	12.8	8.0	4.8	2.2	0.0	
26.4	22.5	18.0	14.0	9.0	5.6	2.7	0.0	
26.8	24.0	19.2	15.2	10.0	6.4	3.1	0.04	
29.1	25.3	20.3	16.1	10.8	7.2	3.5	0.06	
30.4	26.8	21.5	17.1	11.6	7.9	3.9	0.08	
31.7	28.0	22.6	18.2	12.5	8.5	4.2	0.10	
34.3	30.8	24.8	20.0	14.0	9.9	4.8	0.20	
37.0	33.5	27.0	21.8	15.5	10.8	5.2	0.30	
...	...	...	...	16.8	11.8	5.5	0.40	

## SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS ALCOHOL AT:

15°.

14.5°.

(Schütz — Liebig's Ann. 128, 365, '61.)

(Bodländer — Z. physik. Ch. 7, 316, '91.)

Sp. Gr. of Alcohol.	Wt. per cent Alcohol.	G. KCl per 100 g. Aq. Alcohol.	Sp. Gr. of Sat. Solutions.	Grams per 100 cc. Solution.		
				C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	KCl.
0.984	10	19.8	1.1720	...	88.10	29.10
0.972	20	14.7	1.1542	2.79	85.78	26.85
0.958	30	10.7	1.1365	4.98	84.00	24.67
0.940	40	7.7	1.1075	10.56	79.63	20.56
0.918	50	5.0	1.1085	15.57	75.24	17.24
0.896	60	2.8	1.0545	20.66	70.52	14.27
0.848	80	0.45	1.0455	24.25	67.05	13.25
Gerardin's results at 15° agree with the above determinations.			0.9695	40.42	50.18	6.35
			0.9315	48.73	40.60	3.82
			0.8448	68.63	15.55	0.30

30° and 40°.

(Bathrick — J. Physic. Chem. 1, 160, '96.)

Wt. per cent Alcohol.	Gms. KCl per 100 Gms. Aq. Alcohol.		Wt. per cent Alcohol.	Gms. KCl per 100 Gms. Aq. Alcohol.	
	At 30°.	At 40°.		At 30°.	At 40°.
0	38.9	41.8	43.1	11.1	13.1
5.28	33.9	35.9	55.9	6.8	8.2
9.43	30.2	33.3	65.9	3.6	4.1
16.9	24.9	27.6	78.1	1.3	1.6
25.1	19.2	21.8	86.2	0.4	0.5
34.1	15.6	17.2			



SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL AT 25°.  
(McIntosh, 1903.)

Wt. % C <sub>2</sub> H <sub>5</sub> OH.	Mols. KCl per Liter.	Gms. KCl per 100 cc. Sat. Sol.	Wt. % C <sub>2</sub> H <sub>5</sub> OH.	Mols. KCl per Liter.	Gms. KCl per 100 cc. Sat. Sol.
0	4.18	31.18	60	0.56	4.18
10	3.21	23.93	70	0.305	2.27
20	2.40	17.89	80	0.125	0.93
30	1.78	13.27	90	0.042	0.31
40	1.26	9.40	100	0.011	0.08
50	0.84	6.26			

SOLUBILITY OF POTASSIUM CHLORIDE IN DILUTE AQUEOUS SOLUTIONS OF METHYL ALCOHOL AT 0° AND AT 25°.  
(Armstrong and Eyre, 1910-11.)

Wt. % CH <sub>3</sub> OH in Solvent.	Gms. KCl per 100 Gms. Sat. Sol. at:	
	0°.	25°.
0	22.06	26.69
0.79	21.74	26.42
1.57	21.39	26.01
3.10	20.61	25.25
8.76	17.84	22.82

SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS METHYL ALCOHOL AT 25°.  
(Hertz and Anders, 1907; McIntosh, 1903.)

Solvent.		$d_{25}^{20}$ of Sat. Sol.	Gms. KCl per 100 cc. Sat. Sol.	Solvent.		$d_{25}^{20}$ of Sat. Sol.	Gms. KCl per 100 cc. Sat. Sol.
$d_{25}^{20}$	Wt. % CH <sub>3</sub> OH.			$d_{25}^{20}$	Wt. % CH <sub>3</sub> OH.		
0.9971	0	1.1782	31.13	0.8820	64	0.9064	3.4
0.9791	10.6	1.125	24.53	0.8489	78.1	0.8607	1.2
0.9481	30.8	1.033	13.65	0.8167	98.9(?)	0.8242	0.2
0.9180	47.1	0.9679	7.61	0.7882	100	0.7937	0.0
100 gms. methyl alcohol dissolve 0.53 gm. KCl at 25°.				(Turner and Bisett, 1910)			
" ethyl		"	0.022	" "		"	"
" propyl		"	0.004	" "		"	"
" amyl		"	0.0008	" "		"	"

Potassium chloride is insoluble in CH<sub>3</sub>OH at the crit. temp. (Centnerswer, 1860)

SOLUBILITY OF POTASSIUM CHLORIDE IN DILUTE AQUEOUS SOLUTIONS OF PROPYL ALCOHOL AT 0° AND AT 25°.  
(Armstrong and Eyre, 1910-11.)

Wt. % C <sub>3</sub> H <sub>7</sub> OH in Solvent.	Gms. KCl per 100 Gms. Sat. Sol. at:	
	0°.	25°.
1	22.06	26.44
1.48	21.25	25.94
2.91	20.49	25.23
5.66	18.97	23.82

SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF GLUCOSE  
(Armstrong and Eyre, 1910-11.)

Wt. % C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> +H <sub>2</sub> O in Aq. Solvent.	Gms. KCl per 100 Gms. Sat. Solution.
0	26.63
4.72	25.86
9	25.18
16.53	23.89
37.27	20.15



## SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS ACETONE SOLUTIONS.

(Snell, 1898; at 20°, Herz and Knoch, 1904.)

tube at 1 in.	At 20°.		At 30°.		At 40°.		At 50°.	
	KCl per 100 cc. Solution.		Gms. per 100 Gms. Solution.		Gms. per 100 Gms. Solution.		Gms. per 100 Gms. Solution.	
	Millimols.	Gms.	Acetone.	KCl.	Acetone.	KCl.	Acetone.	KCl.
	410.5	30.62	0	27.27	0	28.69	0	30
	351.7	26.23	6.96	23.42	6.79	25.33	...	...
	286.6	21.38	16.22	18.90	15.75	21.28	...	...
	223.7	16.69	25.45	15.06	two layers		25.67	14.42
	166.5	12.42	35.52	11.31	"		36.03	9.93
	115.4	8.61	45.98	8.04	"		46.46	7.07
	71.2	5.31	56.91	5.12	"		57.37	4.38
	38.5	2.87	68.18	2.60	"		68.56	2.22
	12.9	0.96	79.43	0.76	79.34	0.58	79.25	0.94
	2	0.15	89.88	0.13	89.84	0.16	±81° sat. sol.	
	0	0	100	0	100	0		

1. — For the 20° results the per cent acetone in the solvent is in terms of volume instead of weight per cent, and the concentration of the second solution is 10 per cent instead of 9.1 which is the weight per cent concentration of the solvent for the corresponding results at the other temperatures.

2. TEMPERATURE 40° AND FOR CONCENTRATIONS OF ACETONE BETWEEN 20 AND 80 PER CENT THE SATURATED SOLUTION SEPARATES INTO TWO LAYERS WITH THE FOLLOWING COMPOSITIONS:

Upper Layer.			Lower Layer.		
Gms. per 100 Gms. Solution.			Gms. per 100 Gms. Solution.		
H <sub>2</sub> O.	(CH <sub>3</sub> ) <sub>2</sub> CO.	KCl.	H <sub>2</sub> O.	(CH <sub>3</sub> ) <sub>2</sub> CO.	KCl.
5.2	31.82	12.99	28.14	69.42	2.44
3.27	35.44	11.29	30.96	65.97	3.07
1.23	48.50	10.27	32.64	63.79	3.56
0.34	39.88	9.77	34.07	62.01	3.92
8.02	43.18	8.79	37.44	57.67	4.89
6.49	45.34	8.17	38.68	56.17	5.25
18.99	25.24	15.77	23.66	74.91	1.43

3. sat. solution of potassium chloride in furfural (C<sub>4</sub>H<sub>3</sub>O.COH) contains 11.5 g. KCl at 25°.

(Walden, 1906.)



# POTASSIUM CHLORIDE

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## SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF GLYCEROL AT 25°. (Herz and Knoch, 1905.)

Sp. Gr. of Glycerol at 25°/4° = 1.2555.				Impurity about 1.5%.			
Wt. Per cent Glycerol in Solvent.	KCl per 100 cc. Solution.		Sp. Gr. of Solutions.	Wt. Per cent Glycerol in Solvent.	KCl per 100 cc. Solution.		Sp. Gr. of Solutions.
	Millimols.	Gms.			Millimols.	Gms.	
0	424.5	31.66	1.180	54.23	238.5	17.79	1.219
13.28	383.4	28.61	1.185	83.84	149	11.11	1.259
25.98	339.3	25.31	1.194	100	110.6	8.25	1.286
45.36	271.4	20.24	1.211				

100 gms. H<sub>2</sub>O dissolve 246.5 gms. sugar + 44.8 gms. KCl at 31.25°, or 100 gms. of the sat. solution contain 62.28 gms. sugar + 11.33 gms. KCl. (Köhler, 1897.)

## SOLUBILITY OF POTASSIUM CHLORIDE IN AQUEOUS SOLUTIONS OF PYRIDINE AT 10°. (Schroeder, 1908.)

Aq. Mixture.		Gms. KCl per 100 Gms. Sat. Sol.	Aq. Mixture.		Gms. KCl per 100 Gms. Sat. Sol.
cc. H <sub>2</sub> O.	cc. Pyridine.		cc. H <sub>2</sub> O.	cc. Pyridine.	
100	0	23.79	40	60	3.33
90	10	19.76	30	70	1.25
80	20	16.37	20	80	0.24
70	30	13.19	10	90	0.04
60	40	10.05	0	100	0
50	50	6.34			

## SOLUBILITY OF POTASSIUM CHLORIDE IN DILUTE AQUEOUS SOLUTIONS OF SEVERAL COMPOUNDS AT 25°. (Armstrong and Eyre, 1913.)

Compound.	Gms. Cmpd. per 1000 Gms. H <sub>2</sub> O.	Gms. KCl per 100 Gms. Sat. Sol.	Compound.	Gms. Cmpd. per 1000 Gms. H <sub>2</sub> O.	Gms. KCl per 100 Gms. Sat. Sol.
Water alone	...	26.89	Glycol	15.51	26.43
Acetaldehyde	11.01	27.05	"	62.05	25.26
Paraldehyde	11.01	26.42	Mannitol	45.53	24.86
Glycerol	13.01	25.58	"	136.59	24.46

100 gms. 95% formic acid dissolve 19.4 gms. KCl at 19.7°. (Aschan, 1913.)  
 " glycerol ( $d_{15} = 1.256$ ) " 3.72 " " " 15-16°. (Ossendowski, 1915.)  
 100 cc. anhydrous hydrazine " 9 " " " room temp. (Welsh and Broderson, 1917.)  
 100 gms. hydroxylamine " 12.3 " " " 17-18°. (de Bruyn, 1892.)

## FUSION-POINT DATA (Solubilities, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES OF POTASSIUM CHLORIDE AND OTHER SALTS.

KCl+KI. { (Wrzesnewski, '12; Amadori & Pampanini, '11; Ruff & Plato, '03.)	KCl+K <sub>2</sub> SO <sub>4</sub> . { (Jaenecke, '12; Sackur, '11-12; Ruff & Plato, '03.)
KCl+KF. (Ruff and Plato, 1903.)	KCl+HgCl (Sackur, 1913.)
KCl+KOH. (Scarpa, 1915.)	KCl+NaCl. (Sackur, '13; Ruff & Plato, '03.)
KCl+KCrO <sub>4</sub> . (Sackur, '11-12; Zemcznzy, '08.)	KCl+Na <sub>2</sub> SO <sub>4</sub> . (Sackur, 1913.)
KCl+KPO <sub>3</sub> . (Amadori, 1912.)	KCl+SrCl <sub>2</sub> . (Vortisch, '14; Sackur, '11-12)
KCl+K <sub>2</sub> P <sub>2</sub> O <sub>7</sub> . "	KCl+TiCl. (Sandonnini, 1911; 1914.)
KCl+K <sub>3</sub> PO <sub>4</sub> . "	

## POTASSIUM CHLOROIRIDATE K<sub>3</sub>IrCl<sub>6</sub>.

100 gms. H<sub>2</sub>O dissolve 1.25 gms. of the salt at 18-20°.  
 100 gms. H<sub>2</sub>O dissolve 9.18 gms. dipotassium aquopentachloroiridite, Ir  
 (H<sub>2</sub>O)K<sub>2</sub> at 19°. (Delepine, 1915.)



**POTASSIUM CHROMATES**  $K_2CrO_4$ ,  $K_2Cr_2O_7$ ,  $K_2Cr_2O_{10}$ , etc.

**EQUILIBRIUM IN THE SYSTEM, POTASSIUM OXIDE, CHROMIC ACID AND WATER AT SEVERAL TEMPERATURES.**  
(Koppel and Blumenthal, 1907.)

Temperatures at 0°.	Results at 30°.		Results at 60°.		Solid Phase at each Temp.
	Gms. per 100 Gms. Sat. Solution.	Gms. Sat. CrO <sub>3</sub>	Gms. per 100 Gms. Sat. Solution.	Gms. Sat. Cr <sub>2</sub> O <sub>7</sub>	
...	46.8	...	about 50	...	KOH. + H <sub>2</sub> O
0.54	26.89	0.94	32.98	0.53	K <sub>2</sub> CrO <sub>4</sub>
4.27	22.25	3.06	21.05	9.15	"
11.77	18.65	13.72	20.25	14.43	"
18.71	19.12	20.30	20.70	21.97	"
19.04	19.35	21	20.61	23.61	" + K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>
11.93	15.04	16.85	14.53	20.82	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>
3.13	11.20	13.11	10.01	21.21	"
22.38	2.42	28.21	6.86	39.64	"
42.95	2.50	44.50	7.06	49.84	" + K <sub>2</sub> Cr <sub>2</sub> O <sub>10</sub>
44.52	...	...	4.06	54.73	K <sub>2</sub> Cr <sub>2</sub> O <sub>10</sub>
46.84	...	...	2	60.69	"
47.40	2.35	49.95	...	...	" + K <sub>2</sub> Cr <sub>2</sub> O <sub>10</sub>
48.23	1.35	53.39	...	...	K <sub>2</sub> Cr <sub>2</sub> O <sub>10</sub>
56.93	...	...	...	...	"
61.79	0.69	62.81	1.27	65.77	" + CrO <sub>3</sub>
61.54	...	62.52	0	65.12	CrO <sub>3</sub>

**CRYOHYDRATES (EUTECTICS) IN THE SYSTEM K<sub>2</sub>O - CrO<sub>3</sub> - H<sub>2</sub>O.**

Points were determined by adding to a sat. solution of  $K_2Cr_2O_7$  successive m. portions of chromic acid and ascertaining the freezing-point and composition of the solution. At the point of appearance of a new solid phase an additional amount of chromic acid does not change the f.-pt. since the added  $CrO_3$  enters the solid phase. This relation also holds at the points where the solution is simultaneously saturated with  $K_2Cr_2O_7$  and  $K_2Cr_2O_{10}$  or  $K_2Cr_2O_{10}$  and

Gms. per 100 Gms. Sat. Solution.		Solid Phase in Equilibrium with Sat. Sol. and Ice.	t° of Equilibrium of Sat. Sol. with Ice.	Gms. per 100 Gms. Sat. Solution.		Solid Phase in Equilibrium with Sat. Sol. and Ice.
K <sub>2</sub> O.	CrO <sub>3</sub> .			K <sub>2</sub> O.	CrO <sub>3</sub> .	
20	5.70	K <sub>2</sub> CrO <sub>4</sub>	-13.22	not det.	27.26	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>
17.52	13.89	"	-14.50	"	28.85	"
17.12	18.18	"	-22.10	"	35.92	"
17.18	18.11	" + K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	-22.11	0.47	36.14	"
8.27	8.01	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	-26.77	0.88	39.86	"
1.38	2.93	"	-30.20	1.18	42.31	" + K <sub>2</sub> Cr <sub>2</sub> O <sub>10</sub>
not det.	6.81	"	-34.01	0.95	43.45	K <sub>2</sub> Cr <sub>2</sub> O <sub>10</sub>
"	16.05	"	-39	0.79	45.65	" + K <sub>2</sub> Cr <sub>2</sub> O <sub>10</sub>
0.48	17.25	"	-49	not det.	49.11	K <sub>2</sub> Cr <sub>2</sub> O <sub>10</sub>
0.45	23.63	"	-61.5	0.61	53.57	"

viscosity of the solutions at the lower temperatures increased so much that hydrate points could not be determined. By graphic extrapolation the rate temperature of chromic acid and of chromic acid + potassium tetra- is near -80° and the  $CrO_3$  content is 59 gms. per 100 gms. sat. solution.



By interpolation from the data given in the preceding tables the following solubilities in water are obtained:

THE ICE CURVE AND SOLUBILITY OF POTASSIUM CHROMATE IN WATER.

t°.	Gms. $K_2CrO_4$ per 100 Gms. $H_2O$ .	Solid Phase.	t°.	Gms. $K_2CrO_4$ per 100 Gms. $H_2O$ .	Solid Phase.
- 0.99	4.53	Ice	- 11.35 Eutec.	54.54	Ice - $K_2CrO_4$
- 1.2	6.12	"	0	57.11	$K_2CrO_4$
- 4.3	26.99	"	30	65.13	"
- 7.12	42.04	"	60	74.60	"
- 10.35	52.41	"	105.8 b. pt.	88.8	"

Potassium Dichromate		Potassium Dichromate + Potassium Chromate.		Potassium Dichromate + Potassium Trichromate.	
t°.	Gms. $K_2Cr_2O_7$ per 100 Gms. $H_2O$ .	t°.	Gms. per 100 Gms. $H_2O$ . $K_2O$ $CrO_3$ .	t°.	Gms. per 100 Gms. Sat. Sol. $K_2O$ $CrO_3$ .
- 0.63*	4.50	- 11.5*	17.18    18.11	- 30*	1.18    2.51
0	4.65	0	17.73    19.03	0	1.47    2.99
30	18.13	+ 30	19.35    21	+ 20	2.20    3.10
60	45.44	60	20.61    23.61	30	2.50    4.50
104.8†	108.2	106.8†	24.3    30.5	60	7.06    49.84
				114†	16.80    59.20

\* Eutec.

† b. pt.

Potassium Trichromate + Potassium Tetrachromate.

t°.	Gms. per 100 Gms. Sat. Sol. $K_2O$ $CrO_3$ .
- 39 Eutec.	0.79    45.69
0	1.37    47.40
20	2    48.46
30	2.25    49.95
60	5.01    54.09

Potassium Tetrachromate + Chromic Acid ( $CrO_3$ ) -

t°.	Gms. per 100 Gms. Sat. Sol. $K_2O$ $CrO_3$ .
0	0.64    61 - 79
20	0.62    62 - 80
30	0.69    62 - 81
60	1.27    65 - 77

Data for boiling points in the system  $K_2O + CrO_3 \cdot H_2O$  determined by means of the Beckmann apparatus, are also given.

The older data for  $K_2CrO_4$  and  $K_2Cr_2O_7$  are as follows:

SOLUBILITY OF EACH IN WATER.

(Alluard, 1864; Nordenskjöld and Lindström, 1869; Etard, 1894; Kremers, 1854; Tilden and Stone, 1884.)

Potassium Chromate.				Potassium Dichromate.	
t°.	Grams per 100 Grams Water.			Grams per 100 Grams Water.	
0	58.2*	59.3†	60.2‡	5*	5§
10	60.0	61.2	62.5	7	7
20	61.7	63.2	64.5	12	12
25	62.5	64.2	64.5	16	16
30	63.4	65.2	66.5	20	20
40	65.2	67.0	68.6	26	27
50	66.8	69.0	70.6	34	37
60	68.6	71.0	72.7	43	47
70	70.4	73.0	74.8	52	58
80	72.1	75.0	76.9	61	70
90	73.9	77.0	79.0	70	82
100	75.6	79.0	82.2	80	97
125	79.0	...	...	110	145
150	83.0	...	...	143	205

\* Etard.

† Alluard.

‡ N. and L.

§ A., K., T. and S.



# SOLUBILITY OF POTASSIUM CHROMATES IN WATER AT 30°.

(Schreinemaker — Z. physik. Ch. 55, 83, '06.)

Composition in Wt. per cent of:				Solid Phase.
The Solution CrO <sub>3</sub> .	Per cent K <sub>2</sub> O.	The Residue. Per cent CrO <sub>3</sub> .	Per cent K <sub>2</sub> O.	
± 47	...	...	...	KOH.H <sub>2</sub> O
	47.16	12.59	47.54	K <sub>2</sub> CrO <sub>4</sub>
175	34.602	10.93	37.47	"
51	26.602	16.482	32.532	"
38	20.584	37.131	39.922	"
27	19.225	27.966	29.377	"
1	19.17	...	...	K <sub>2</sub> CrO <sub>4</sub> + K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>
36	17.30	37.64	22.61	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>
5	7.88	...	...	"
3	3.412	25.85	7.82	"
1	3.01	49.45	9.91	"
5	3.245	53.94	12.40	K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> + K <sub>2</sub> Cr <sub>2</sub> O <sub>8</sub>
38	2.823	60.314	12.935	K <sub>2</sub> Cr <sub>2</sub> O <sub>8</sub>
57	2.353	63.044	11.684	K <sub>2</sub> Cr <sub>2</sub> O <sub>8</sub> + K <sub>2</sub> Cr <sub>2</sub> O <sub>9</sub>
15	1.360	62.958	8.002	K <sub>2</sub> Cr <sub>2</sub> O <sub>9</sub>
5	0.796	67.944	6.731	"
27	0.621	70.0	4.0	K <sub>2</sub> Cr <sub>2</sub> O <sub>9</sub> + CrO <sub>3</sub>
3	0.0	...	...	CrO <sub>3</sub>

t. solution in glycol, C<sub>2</sub>H<sub>4</sub>(OH)<sub>2</sub>.H<sub>2</sub>O, contain 1.7 gms. K<sub>2</sub>CrO<sub>4</sub> at 15.4°.t. solution in glycol, C<sub>2</sub>H<sub>4</sub>(OH)<sub>2</sub>.H<sub>2</sub>O, contain 6 gms. K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> at 14.6°.

(de Coninck, 1905.)

O dissolve 10.1 gms. K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> at 15.5°.

(Greenish and Smith, 1901.)

t. solution in water contain 5.52 gms. K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> at 4.81°, 15.17 gms.

17.77 gms. at 35.33°.

(Le Blanc and Schmandt, 1911.)

aqueous solution contain 11.43 gms. K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> at 20°.

(Sherrill and Eaton, 1907.)

## SOLUBILITY OF POTASSIUM CHROMATE IN AQUEOUS SOLUTIONS OF POTASSIUM MOLYBDATE AT 25° AND VICE VERSA.

(Amadori, 1912a.)

Gms. H <sub>2</sub> O.	Gms. per 100 Gms. H <sub>2</sub> O.		Gms. per 100 Gms. H <sub>2</sub> O.	
K <sub>2</sub> MoO <sub>4</sub> .	K <sub>2</sub> CrO <sub>4</sub> .	K <sub>2</sub> MoO <sub>4</sub> .	K <sub>2</sub> CrO <sub>4</sub> .	K <sub>2</sub> MoO <sub>4</sub> .
0	14.13	98.72	4.92	165.4
15.37	10.07	118.8	2.14	180.8
38.79	10.24	119.9	1.70	183
50.96	7.12	137.8	0	184.6
	6.37	157.2		

## SOLUBILITY OF POTASSIUM CHROMATE IN AQUEOUS SOLUTIONS OF POTASSIUM SULFATE AT 25° AND VICE VERSA.

(Amadori, 1912a.)

Gms. H <sub>2</sub> O.	Gms. per 100 Gms. H <sub>2</sub> O.		Gms. per 100 Gms. H <sub>2</sub> O.	
K <sub>2</sub> SO <sub>4</sub> .	K <sub>2</sub> CrO <sub>4</sub> .	K <sub>2</sub> SO <sub>4</sub> .	K <sub>2</sub> CrO <sub>4</sub> .	K <sub>2</sub> SO <sub>4</sub> .
0.76	40.93	3.33	7.81	8.98
1.17	27.36	4.82	4.36	10.25
1.84	20.83	5.72	1.94	10.86
2.36	14.65	7.12	0	12.10

aqueous hydrazine dissolve 1 gm. K<sub>2</sub>CrO<sub>4</sub> at room temp. } (Welsh and Broderson, 1915.)  
 aqueous hydrazine dissolve 1 gm. K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> at room temp. }



FREEZING-POINT DATA (Solubilities, see footnote, p. 1) FOR MIXTURES OF POTASSIUM CHROMATES AND OTHER COMPOUNDS.

$K_2CrO_4 + K_2Cr_2O_7$	(Groschuff, 1908.)
$K_2CrO_4 + K_2MoO_4$	(Amadori, 1913.)
$K_2Cr_2O_7 + K_2Mo_2O_7$	"
$K_2CrO_4 + K_2SO_4$	(Amadori, 1913; Groschuff, 1908.)
$K_2CrO_4 + K_2WO_4$	(Amadori, 1913.)
$K_2Cr_2O_7 + K_2W_2O_7$	"

POTASSIUM CITRATE  $(CH_3)_3C(OH)(COOK)_3 \cdot H_2O$ .

SOLUBILITY IN WATER.

(Average results of Seidell, 1910; Greenish and Smith, 1901; Köhler, 1897.)

t°.	Gms. $(CH_3)_3C(OH)(COOK)_3 \cdot H_2O$ per 100 Gms.	
	Sat. Solution.	Water.
15	61.8	162
20	63.2	172
25	64.5	182 ( $d_{25} = 1.518$ )
30	66	194

100 gms.  $H_2O$  dissolve 198.3 gms.  $(CH_3)_3COH(COOK)_3 + 303.9$  gms. cane sugar at  $31.25^\circ$ . (Köhler, 1897.)

SOLUBILITY OF POTASSIUM CITRATE IN AQUEOUS ETHYL ALCOHOL AT  $25^\circ$ . (Seidell, 1910.)

When potassium citrate is added to aqueous alcohol of certain concentrations the mixture separates into two liquid layers. A series of determinations made by adding an excess of the salt to 10–15 cc. portions of several aq. alcohol mixtures at  $25^\circ$  gave the following results.

Wt. % $C_2H_5OH$ in Solvent.	$d_{25}$ of Sat. Solution.	Wt. % $C_2H_5OH$ in Sat. Solution.	Gms. $(CH_3)_3COH(COOK)_3 \cdot H_2O$ per 100 Gms. Sat. Solution.
8.9	{ a ... b 1.4920	...	60
32	{ a ... b 1.4930	...	0.2 61.6
51	{ a ... b ...	65.1	0.38 62.5
70.2	{ a 0.8366 b ...	81	0.10 62.3
81.4	0.8356	81.4	0.038
91.6	0.8139	91.6	0.016
99.9	0.7896	99.5	0.014

a = upper, alcohol rich layer. b = lower, water rich layer.

A series of determinations was also made by adding just enough potassium citrate to the alcohol solution to cause distinct clouding and then, after bringing to  $25^\circ$ , titrating with the aqueous alcohol mixture to disappearance of the cloud. The results were plotted and the following interpolated values obtained.

Wt. % $C_2H_5OH$ in Solvent.	$d_{25}$ of Sat. Solution.	Gms. $(CH_3)_3COH(COOK)_3 \cdot H_2O$ per 100 Gms. Sat. Sol.	Wt. % $C_2H_5OH$ in Solvent.	$d_{25}$ of Sat. Solution.	Gms. $(CH_3)_3COH(COOK)_3 \cdot H_2O$ per 100 Gms. Sat. Sol.
0	1.518	64.5	40	1.005	12.4
5	1.400	52.5	50	0.943	5.
10	1.310	45.5	60	0.900	1.
20	1.177	31.5	70	0.868	0.
30	1.085	21.5	80	0.838	0.

In one determination at  $15^\circ$ , made with alcohol of 59 Vol. per cent, 4.5 gms.  $(CH_3)_3COH(COOK)_3 \cdot H_2O$  were required to just cause clouding.



**K CYANATE KCNO.****SOLUBILITY IN ALCOHOLIC MIXTURES.**  
(Erdmann, 1893.)

Solvent.	Gms. KCNO per Liter Solvent at b.-pt.
nt Alcohol + 20 per cent Water	62
nt Alcohol + 20 per cent Methyl Alcohol	76
nt Alcohol + 10 per cent Acetone	82

**K CYANIDE KCN.**

H<sub>2</sub>O dissolve 122.2 gms. KCN, or 100 gms. sat. solution contain 55  
t 103.3°. (Griffiths.)

bs. ethyl alcohol dissolve 0.87 gm. KCN at 19.5°.

bs. methyl alcohol dissolve 4.91 gms. KCN at 19.5°. (de Bruyn, 1892.)

lycerol dissolve 32 gms. KCN at 15.5°. (Ossendowski, 1907.)

ydroxylamine dissolve 41 gms. KCN at 17.5°. (de Bruyn, 1892.)

a for KCN + KCl, KCN + NaCN, KCN + AgCN, KCN + Cu<sub>2</sub>  
r KCN + Zn(CN)<sub>2</sub> are given by Truthe (1912).

**K CHROMOCYANIDE K<sub>3</sub>Cr(CN)<sub>6</sub>.**

H<sub>2</sub>O dissolve 32.33 gms. K<sub>3</sub>Cr(CN)<sub>6</sub> at 20°. (Moissan, 1885; Christensen, 1885.)

**K CHROMITHIOCYANATE K<sub>3</sub>Cr(SCN)<sub>6</sub>·4H<sub>2</sub>O.**

H<sub>2</sub>O dissolve 139 gms. salt. (Karsten, 1861-5.)

**K CARBONYL FERROCYANIDE K<sub>3</sub>FeCO(CN)<sub>5</sub>·3½H<sub>2</sub>O.**

H<sub>2</sub>O dissolve 148 gms. salt at 16°. (Müller, 1887.)

**K FERRICYANIDE K<sub>3</sub>Fe(CN)<sub>6</sub>.****K FERROCYANIDE K<sub>4</sub>Fe(CN)<sub>6</sub>·3H<sub>2</sub>O.****SOLUBILITY OF EACH IN WATER.**

allace, 1855; Etard, 1894; Schiff, 1860; Michel and Kraft, 1858; Thomsen.)

The available determinations fall very irregularly when plotted on  
paper, and the following figures, which are averages, are therefore  
than rough approximations to the true amounts. The figures under  
how the limits between which the correct values probably lie.

Gms. per 100 Gms. H <sub>2</sub> O.			t°.	Gms. per 100 Gms. H <sub>2</sub> O.		
K <sub>3</sub> Fe(CN) <sub>6</sub> .	K <sub>4</sub> Fe(CN) <sub>6</sub> .			K <sub>3</sub> Fe(CN) <sub>6</sub> .	K <sub>4</sub> Fe(CN) <sub>6</sub> .	
31	13	...	40	60	38	70
36	20	20	60	66	52	83
43	25	40	80	...	66	89
46	28	48	100	...	76	91
50	32	57	104.4	82.6	...	...

H<sub>2</sub>O dissolve 0.08946 gm. mols. = 32.97 gms. K<sub>4</sub>Fe(CN)<sub>6</sub> at 25°, *d*<sub>25</sub> of  
0908. (Harkins and Pearce, 1916.)

f sat. solution in water contains 319.4 gms. K<sub>4</sub>Fe(CN)<sub>6</sub>·3H<sub>2</sub>O at 25°. (Grube, 1914.)

arkins and Pearce figure for *d*<sub>25</sub>, this result corresponds to 34.3 gms.  
er 100 gms. H<sub>2</sub>O.

f sat. solution in water contains 385.5 gms. K<sub>3</sub>Fe(CN)<sub>6</sub> at 25°. (Grube, 1916.)



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0.0628

1.949

(Welsh and Broderman, 1943)

SOLUTIONS AT 25°. (Grube, 1914.)

SECRET

**ANTIDOTE**

1. 1. E. P. (CND) 1. E. P. (CND) 1. E. P. (CND)

ONS 

**2.**

$$\text{K}_2\text{Zn}(\text{CN})_4$$

at 20°.

(Sharwood, 190

 $\text{KF} \cdot 2\text{H}_2\text{O}$ 

KF, or 100 gms. sat. solution contain 48

(Mylius and Funk)

(Ditte, 1896.)

Gms. per 100 Gms. H<sub>2</sub>O.



to de Forcrand (1911), a saturated solution of  $\text{KF} \cdot 2\text{H}_2\text{O}$  in water at composition 1 mol.  $\text{KF} + 3.90$  mols.  $\text{H}_2\text{O} = 45.3$  gms. per 100 gms. sat. the solution in contact with  $\text{KF} \cdot 4\text{H}_2\text{O}$  as solid phase, has the composition  $\text{KF} + 5.76$  mols.  $\text{H}_2\text{O} = 35.96$  gms.  $\text{KF}$  per 100 gms. sat. solution.

PHASE DIAGRAM IN THE SYSTEM POTASSIUM FLUORIDE, ETHYL ALCOHOL AND WATER AT  $23^\circ$ – $26^\circ$ .  
(Frankforter and Frary, 1913.)

As determined the binodal curve, the quadruple points and two tie lines.

per 100 Gms. Upper Layer.		Gms. per 100 Gms. Lower Layer.		
$\text{C}_2\text{H}_5\text{OH}$ .	$\text{H}_2\text{O}$ .	$\text{KF}$ .	$\text{C}_2\text{H}_5\text{OH}$ .	$\text{H}_2\text{O}$ .
92.67	6.07*	45.33	0.67	54*
...	...	37.82	1.70	60.49
83.30	15.54	...	...	...
...	...	28.68	4.47	66.85
65.81	31.33	...	...	...
57.4	38.13	20.90	11.9	67.2†
53.04	41.49	...	...	...
...	...	18.55	15.6	65.85
47.52	45.55	...	...	...
41.28	49.88	15.7	21.8	62.5†
38.66	51.79	...	...	...
...	...	13.57	27.27	59.15
35.91	53.57	...	...	...
...	...	11.43	33.23	54.34
30	59	11	30	59‡

Quad. points.

† Tie line.

‡ Plait point approx.

for the determination of alcohol in unknown mixtures, based upon the method described by the authors.

L L CURVE FOR THE SYSTEM POTASSIUM FLUORIDE, PROPYL ALCOHOL AND WATER AT  $23^\circ$ – $26^\circ$ .  
(Frankforter and Frary, 1913.)

per 100 Gms. Homogeneous Liquid.		Gms. per 100 Gms. Homogeneous Liquid.		
$\text{C}_3\text{H}_7\text{OH}$ .	$\text{H}_2\text{O}$ .	$\text{KF}$ .	$\text{C}_3\text{H}_7\text{OH}$ .	$\text{H}_2\text{O}$ .
96.78	3.05*	8.15	7.49	84.36
78.91	21.19	10	5.97	84.03
66.29	33.09	12.21	4.39	83.41
59.97	39.22	14.18	3.45	82.37
47.46	51.21	18.75	1.89	79.35
35.40	62.83	25.83	0.74	73.43
19.05	78.45	35.38	0.23	64.38
10.64	84.04	47.62	0.039	52.34*

\* Quad. point.

As determined. In this case the upper layer contained 78.91%  $\text{C}_3\text{H}_7\text{OH}$ , 0.31%  $\text{KF}$ , and the lower layer contained 9.67%  $\text{KF}$ .

In this system, the effect of change in temperature is more marked than in the system in which ethyl alcohol is present.

A saturated solution of potassium fluoride in 99.6% propyl alcohol contains 0.039%  $\text{KF}$  at room temp.  
(Frankforter and Frary, 1913.)

L L CURVE FOR THE SYSTEM POTASSIUM FLUORIDE, ISOPROPYL ALCOHOL AND WATER AT  $20^\circ$ .  
(Frankforter and Temple, 1915.)

Terms of gms. per 100 gms. of solvent, alcohol + water.

per 100 Gms. Solvent.		Gms. per 100 Gms. Solvent.		
$\text{CH}_3\text{CHOHCH}_3$ .	$\text{H}_2\text{O}$ .	$\text{KF}$ .	$\text{CH}_3\text{CHOHCH}_3$ .	$\text{H}_2\text{O}$ .
1.555	98.445	12.385	21.438	78.562
2.965	97.035	5.071	59.339	40.661
6.525	93.475	3.973	65.455	34.545
12.215	87.785	1.705	82.750	17.250



BINODAL CURVE FOR THE SYSTEM POTASSIUM FLUORIDE, ALLYL ALCOHOL AND WATER AT 20°.  
(Frankforter and Temple, 1915.)

The results are given in terms of grams per 100 gms. Alcohol + Water instead of gms. per 100 gms. of the homogeneous mixture.

Gms. per 100 Gms. Solvent.			Gms. per 100 Gms. Solvent.		
KF.	CH <sub>3</sub> :CH.CH <sub>2</sub> OH.	H <sub>2</sub> O.	KF.	CH <sub>3</sub> :CH.CH <sub>2</sub> OH.	H <sub>2</sub> O.
45.707	2.270	97.730	7.508	35.390	64.610
38.076	3.983	96.017	6.024	42.011	57.989
30.675	5.879	94.121	4.813	47.550	52.450
24.341	7.129	92.871	3.631	54.211	45.789
20.580	9.691	90.309	2.236	59.948	36.443
17.371	11.491	88.509	1.931	65.630	34.370
13.184	17.764	82.236	1.635	68.845	31.155
10.880	22.537	77.463	1.368	71.395	28.605
8.873	29.529	70.471	1.066	75.377	24.223

BINODAL CURVE FOR THE SYSTEM POTASSIUM FLUORIDE, ACETONE —, WATER AT 20°.  
(Frankforter and Cohen, 1914.)

Gms. per 100 Gms. Homogeneous Mixture.			Gms. per 100 Gms. Homogeneous Mixture.		
KF.	(CH <sub>3</sub> ) <sub>2</sub> CO.	H <sub>2</sub> O.	KF.	(CH <sub>3</sub> ) <sub>2</sub> CO.	H <sub>2</sub> O.
46.3	trace	53.7*	9.17	23.53	67.30
44.24	0.24	55.52	5	38.72	56.28
33.34	1	65.66	3.06	47.89	46.84
29.86	1.60	68.54	1.38	58.06	40.55
25.74	3.02	71.24	0.979	62.60	36.42
20.28	5.90	73.80	0.75	65.41	33.84
16.31	9.72	73.97	0.50	69.58	29.92
12.40	15.59	72.01	0	98	2*

\* Quad. point.

Data for 4 tie lines are also given and the approximate position of the plait point is shown on the diagram.

Several points on the binodal curves at temperatures between 0° and 35° are also given.

A discussion, with examples, is given of the applicability of the above data to the determination of acetone in unknown mixtures.

BINODAL CURVE FOR THE SYSTEM POTASSIUM FLUORIDE, METHYL ETHYL KETONE AND WATER AT 20°.  
(Frankforter and Cohen, 1916.)

Gms. per 100 Gms. Homogeneous Mixture.			Gms. per 100 Gms. Homogeneous Mixture.		
KF.	CH <sub>3</sub> .CO.C <sub>2</sub> H <sub>5</sub> .	H <sub>2</sub> O.	KF.	CH <sub>3</sub> .CO.C <sub>2</sub> H <sub>5</sub> .	H <sub>2</sub> O.
34.38	0.17	65.45	10.50	4.87	84.63
23.63	0.50	75.87	5.70	9.93	84.37
18.62	1.49	79.89	3.96	12.42	83.61
15.91	2.19	81.90	0.84	21.23	77.93
13.80	2.98	83.22	0.34	23.55	76.11

Freezing-point data (solubilities, see footnote, p. 1) for mixtures of KF are given by Ruff and Plato (1903). Results for KF + KOH by Scarpa (1912). Results for KF + KPO<sub>3</sub>, KF + K<sub>4</sub>P<sub>2</sub>O<sub>7</sub> and KF + K<sub>3</sub>PO<sub>4</sub> are given by Karandeeff (1909). Results for KF + NaF are given by Kurnakow and Zemczynny (1907).



**SIIUM FORMATE HCOOH.**

SOLUBILITY OF POTASSIUM FORMATE AND OF THE ACID SALT IN WATER.  
(Groschuff, 1903.)

Phase : HCOOK.		Solid Phase : HCOOK.HCOOH.					
Gms. HCOOK per 100 Gms. Solution.	Mols. HCOOK per 100 Mols. H <sub>2</sub> O.	Gms. HCOOK.HCOOH per 100 Gms. Solution.	t°.	Gms. HCOOK per 100 Gms. Solution.	t°.	Gms. HCOOK per 100 Gms. Solution.	Mols. HCOOH per 1 Mol. HCOOK.
72.8	57.4	0	60.4	39.0	0	36.3	3.21
76.8	71.0	25	69.8	45.1	19.5	38.2	2.96
80.7	89.8	50	79.2	51.2	39.3	40.8	2.65
86.8	141.0	80	90.7	58.6	60	44.0	2.33
92.0	247.0				70	45.9	2.16
96.0	511				90	52.1	1.68
100.0	∞						

r. of sat. solution at 18° = 1.573.

— Since the acid salt is less soluble at ordinary temperatures than the salt, it can be precipitated from the solution of the neutral salt by adding aqueous formic acid. Proceeding in this way an impure product is obtaining solubility values (expressed in HCOOK) as shown in the last three above.

**SIIUM GERMANIUM FLUORIDE K<sub>2</sub>GeF<sub>6</sub>.**

SOLUBILITY IN WATER.  
(Winkler, 1887; Kruss and Nilson, 1887.)

ms. H<sub>2</sub>O dissolve 173.98 gms. K<sub>2</sub>GeF<sub>6</sub> at 18°, and 34.07 gms. at 100° (W.).  
ms. H<sub>2</sub>O dissolve 184.61 gms. K<sub>2</sub>GeF<sub>6</sub> at 18°, and 38.76 gms. at 100° (N.).

**SIIUM HYDROXIDE KOH.**

SOLUBILITY IN WATER.  
(Pickering, 1893; at 15°, Ferchland, 1902.)

Gms. KOH per 100 Gms.		Solid Phase.	t°.	Gms. KOH per 100 Gms.		Solid Phase.
Water.	Solution.			Water.	Solution.	
3.7	3.6	Ice	15	107	51.7	KOH.H <sub>2</sub> O
22.5	18.4	"	20	112	52.8	"
44.5	30.8	"	30	126	55.76	"
36.2	26.6	KOH.H <sub>2</sub> O	32.5	135	57.44	KOH.H <sub>2</sub> O +
77.94	43.8	"	50	140	58.33	KOH.H <sub>2</sub> O
80	44.4	KOH.H <sub>2</sub> O + KOH.H <sub>2</sub> O	100	178	64.03	KOH.H <sub>2</sub> O
85	45.9	KOH.H <sub>2</sub> O	125	213	68.06	"
97	49.2	"	143	311.7	75.73	"
103	50.7	"				

r. of sat. solution at 15° = 1.5355.

ms. sat. solution in H<sub>2</sub>O contain 50.48 gms. KOH at 15°.

ms. sat. solution in H<sub>2</sub>O contain 53.1 gms. KOH at 15°.  
(de Forcrand, 1909.)  
(Greenish and Smith, 1901.)



SOLUBILITY OF POTASSIUM HYDROXIDE IN AQUEOUS SOLUTIONS OF ALCOHOL AT 30°. (deWaal, 1910.)

Gms. per 100 Gms. Sat. Sol.			Solid Phase.	Gms. per 100 Gms. Sat. Sol.			Solid Phase.
KOH.	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.		KOH.	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	
55.75	0	44.25	KOH.2H <sub>2</sub> O	27.67	69.92	2.41	KOH
54.81	0.43	44.76	"	27.20	73.01	negative*	"
Two liquid layers are formed here.				26.25	81.95	"	"
31	57.50	11.50	KOH.2H <sub>2</sub> O				
28.99	65.07	5.94	"				

\* Negative on account of reaction  $\text{KOH} + \text{C}_2\text{H}_5\text{OH} \rightarrow \text{C}_2\text{H}_5\text{OK} + \text{H}_2\text{O}$ .

Data for equilibrium in the system potassium hydroxide, phenol, water at 25° are given by van Meurs (1916).

Freezing-point data for KOH + RbOH and KOH + NaOH are given by Hevesy (1900). Results for KOH + KI are given by Scarpa (1915).

POTASSIUM IODATE KIO<sub>3</sub>.

SOLUBILITY IN WATER.

(Kremers, 1856; at 30°, Meerburg, 1904.)

t°.	0°	20°	30°	40°	60°	80°	100°
Gms. KIO <sub>3</sub> per 100 gms. H <sub>2</sub> O	4.73	8.13	11.73	12.8	18.5	24.8	32.2
100 gms. H <sub>2</sub> O dissolve 1.3 gms. potassium hydrogen iodate, KH(IO <sub>3</sub> ) <sub>2</sub> , at 15°, and 5.4 gms. at 17°. (Serullas)							
100 gms. H <sub>2</sub> O dissolve 4 gms. potassium dihydrogen iodate, KH <sub>2</sub> (IO <sub>3</sub> ) <sub>2</sub> , at 15°. (Meincke, 1891.)							

EQUILIBRIUM IN THE SYSTEM POTASSIUM IODATE, IODIC ACID, WATER AT 30°. (Meerburg, 1905.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
HIO <sub>3</sub> .	KIO <sub>3</sub> .		HIO <sub>3</sub> .	KIO <sub>3</sub> .	
0	9.51	KIO <sub>3</sub>	3.47	3.59	KIO <sub>3</sub> .2HIO <sub>3</sub> (unstable)
0.65	9.49	" + KIO <sub>3</sub> .HIO <sub>3</sub>	4.80	2.90	" "
0.65	8.90	KIO <sub>3</sub> .HIO <sub>3</sub>	6.45	1.35	" "
0.67	6.6	"	9.35	0.64	KIO <sub>3</sub> .2HIO <sub>3</sub>
1.14	4.57	"	12.04	0.44	"
1.69	3.63	"	17.50	0.30	"
2.02	3.10	"	31.20	0.52	"
3.34	2.10	"	53.64	0.68	"
5	1.32	"	62.52	0.72	"
7.09	1	"	76.40	0.80	" + HIO <sub>3</sub>
8.04	0.85	" + KIO <sub>3</sub> .2HIO <sub>3</sub>	76.7	0	HIO <sub>3</sub>

100 cc. anhydrous Hydrazine dissolve 1 gm. KIO<sub>3</sub> at room temp.

(Welsh and Broderick, 1915.)

POTASSIUM PERIODATE KIO<sub>4</sub>.

100 gms. H<sub>2</sub>O dissolve 0.66 gm. KIO<sub>4</sub> at 13°, d<sub>15</sub> of sat. solution = 1.0051.

(Barker, 1908.)

POTASSIUM IODIDE

SOLUBILITY IN WATER, DETERMINED BY THE FREEZING-POINT METHOD. (Kreman and Kerschbaum, 1907.)

t°.	Gms. KI per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. KI per 100 Gms. Sat. Sol.	Solid Phase.
-12.5	38	Ice	-22.5	52.1	KI
-15	41.2	"	-20	52.6	"
-17.5	44.6	"	-15	53.5	"
-20	48	"	-10	54.5	"
-22.5	51.2	"	-5	55.4	"
-23.2 Eutec.	51.9	" + KI	0	56.4	"



## POTASSIUM IODIDE KI.

## SOLUBILITY IN WATER.

[Salzer, de Coppet, 1883; Etard, 1894; Meusser, 1905; see also Tilden and Shenstone, 1884; Schreinemakers, 1892.]

t°.	Gms. KI per 100 Gms.		t°.	Gms. KI per 100 Gms.	
	Water.	Solution.		Water.	Solution.
-10	115.1	53.5	80	192	65.8
-5	119.8	54.5	90	200	66.7
-1	122.2	55.0	100	208	67.5
0	127.5	56.0	110	215	68.3
10	136	57.6	120	223	69.0
20	144	59.0	Ice Curve		
25	148	59.7			
30	152	60.3	-5	25.7	22.5
40	160	61.5	-7	42.6	29.9
50	168	62.7	-9.5	51.5	34.0
60	176	63.7	-11.5	64.7	39.3
70	184	64.8	-14	75.8	42.7

Gr. of sat. solution at 15.2° = 1.704. (Greenish and Smith, 1901.)  
 Individual determinations, in good agreement with the above results, are given by Van Dam and Donk (1911), and by Greenish and Smith (1901).

SOLUBILITY OF POTASSIUM IODIDE + IODINE IN WATER AT 25°.  
 (Foote and Chalker, 1908.)

Gms. per 100 Gms. Sat. Sol.	Present in		Gms. per 100 Gms. Sat. Sol.	Present in	
	KI.	I - KI.		KI.	I - KI.
45	64.34	34.89	25.88	68.79	42.91
91	63.88	34.97	25.57	69.01	43.44
84	66.54	39.70	27.86	66.56	
18	67.14	39.96	27.27	66.91	
14	66.60	39.46	26.95	67.17	
			25.71	67.91	

Experiments of Hamberger (1906) are discussed. (See also p. 326.)

SOLUBILITY OF MIXTURES OF POTASSIUM IODIDE AND SILVER IODIDE IN  
 WATER AT 0°, 30° AND 50°.  
 (Van Dam and Donk, 1911.)

Results at 0°.			Results at 30°.			Results at 50°.		
Gms. per 100 Gms. Sat. Sol.	KI.		Gms. per 100 Gms. Sat. Sol.	AgI.	KI.	Gms. per 100 Gms. Sat. Sol.	AgI.	KI.
56.1			0		60.35	0		62.6
53			16		55.5	10.7		59.1
51.2			35.8		46.9	22.8		55.5
46.6			42.8		43.9	45		43.2
44			44.1		43.2	53.4		37.6
42.7			47.7		40.9	53.5		37.1
41.3			49.7		38.6	53.5		36.6
36.4			42.8		38.8	53.5		36.5
34.6			29.4		37.6	39		38.1
26.1			10		31.4	28		36.7
20.5			...		...	16		33.8
9.8			0.1		10.2	2.5		24.8
48.7			...		...	...		...
50.3			...		...	...		...

KI  
 "  
 "  
 "  
 " + AgI.KI  
 AgI.KI  
 " + AgI  
 AgI  
 "  
 "  
 "  
 AgI.2KI + KI  
 AgI.2KI



SOLUBILITY OF POTASSIUM IODIDE IN DILUTE AQUEOUS SOLUTIONS OF ALCOHOL AT 25°.

(Armstrong, Eyre, Hussey, and Paddison, 1907.)

Wt. Per cent C <sub>2</sub> H <sub>5</sub> OH in Solvent.	$d_{44}^{\circ}$ of Sat. Sol.	Gms. KI per 100 Gms. Sat. Sol.	Wt. Per cent C <sub>2</sub> H <sub>5</sub> OH in Solvent.	$d_{44}^{\circ}$ of Sat. Sol.	Gms. KI per 100 Sat. Sol.
0	1.7268	59.80	4.41	1.6833	58.08
1.14	1.7154	59.41	12.14	1.6063	54.93
2.25	1.7042	58.95	18.73	1.5420	52.08

100 gms. aqueous 94% ethyl alcohol dissolve 3.99 gms. KI at 17°. (de Bruyn, 1892.)  
 100 gms. aqueous 98% methyl alcohol dissolve 17.1 gms. KI at 17°. "  
 100 cc. of ethyl alcohol of  $d_{44}^{\circ} = 0.8292$  dissolve 8.83 gms. KI at 15°,  $d_{44}^{\circ}$  of solution = 0.8989. (Greenish and Smith, 1902.)

SOLUBILITY OF POTASSIUM IODIDE IN ABSOLUTE ALCOHOLS.

(de Bruyn — Z. physik. Ch. 10, 783, '92; Rohland — Z. anorg. Ch. 18, 327, '98.)

100 gms. methyl alcohol dissolve 16.5 gms. KI at 20.5°.  
 100 gms. ethyl alcohol dissolve 1.75 gms. KI at 20.5°.  
 100 gms. propyl alcohol dissolve 0.46 gm. KI at 15°–20° (R.).

SOLUBILITY OF POTASSIUM IODIDE IN:

Ethyl Alcohol  
of 0.9496 Sp. Gr.

Aqueous Ethyl Alcohol at 18°.

t°.	Gms. KI per 100 Gms. Alcohol	Sp. Gr. of Alcohol.	Weight per cent Alcohol.	Gms. KI per 100 Gms. Alcohol.	Sp. Gr. of Alcohol.	Weight per cent Alcohol.	Gms. KI per 100 Gms. Alcohol.
8	67.4	0.9904	5.2	130.5	0.9390	45	66.4
13	69.2	0.9851	9.8	119.4	0.9088	59	48.3
25	75.1	0.9726	23.0	100.1	0.8464	86	11.4
46	84.7	0.9665	29.0	89.9	0.8322	91	6.2
55	87.5	0.9528	38.0	76.9			
62	90.2						

(Gerardin — Ann. chim. phys. [4] 5, 155)

SOLUBILITY OF POTASSIUM IODIDE IN AQUEOUS SOLUTIONS OF METHYL ALCOHOL AT 25°.

(Herz and Anders, 1907.)

Solvent.		Sat. Solution.		Solvent.		Sat. Solution.	
$d_{44}^{\circ}$ .	Wt. Per cent CH <sub>3</sub> OH.	$d_{44}^{\circ}$ .	Gms. KI per 100 cc.	$d_{44}^{\circ}$ .	Wt. Per cent CH <sub>3</sub> OH.	$d_{44}^{\circ}$ .	Gms. KI per 100 cc.
0.9971	0	1.7213	102.9	0.8820	64	1.185	40 — 33
0.9791	10.6	1.634	92.12	0.8489	78.1	1.066	28 — 05
0.9481	30.8	1.460	71.55	0.8167	93.9	0.9700	18 — 76
0.9180	47.1	1.325	55.6	0.7881	100	0.9018	13 — 28

SOLUBILITY OF POTASSIUM IODIDE IN SEVERAL ALCOHOLS.

Alcohol.	t°.	Gms. KI per 100 Gms. Alcohol.	Authority.
Methyl Alcohol	11.4	13.5	(Timofciew, 1894.)
"	12.2	14.6	"
"	13.5	16	"
"	25	18.04	(Turner and Bissett, 1913)
Ethyl	13.6	1.63	(Timofciew, 1894.)
"	25	2.16	(Turner and Bissett, 1913)
Propyl	12.2	0.731	(Timofciew, 1894.)
"	25	0.43	(Turner and Bissett, 1913)
Amyl	25	0.098	"

100 cc. sat. solution of KI in ethyl alcohol contain 1.585 gms. KI at 25°.



**SOLUBILITY OF POTASSIUM IODIDE IN LIQUID METHYL ALCOHOL AT TEMPERATURES UP TO THE CRITICAL POINT.**

(Tyrer, 1910.)

terminations by the Sealed Tube Method.)

Gms. KI per 100 Gms. CH <sub>3</sub> OH.	t°.	Gms. KI per 100 Gms. CH <sub>3</sub> OH.	t°.	Gms. KI per 100 Gms. CH <sub>3</sub> OH.
14.50	120	27.2	220	27.5
16.20	140	29.2	240	24.8
18.9	160	30.6	245	22.6
22.5	180	30.7	247	21
25	200	29.1	250	13.8
		crit. temp. 252.5		7.6

**SOLUBILITY OF POTASSIUM IODIDE IN VAPOR OF METHYL ALCOHOL ABOVE THE CRITICAL POINT.**

(Tyrer, 1910a.)

wt. H <sub>2</sub> O r apor.	Gms. KI Dissolved per 100 Gms. Solvent at:				
	252°.	270°.	280°.	290°.	300°.
1	0.3	...	...	...	...
2	1	1	1	1	1
3	3.7	3.5	3.4	3.4	3.3
36	7.6	7.4	7.3	7.2	7
4	11.8	11.5	11.3	11	...
45	18.1	...	...	...	...

for the above system are also given by Centnerszwer (1910). This gives the crit. temp. as 266° and the corresponding concentration as 8.64 g per 100 gms. of the sat. solution.

**SOLUBILITY OF POTASSIUM IODIDE IN MIXTURES OF ALCOHOLS AT 25°.**

(Herz and Kuhn, 1908.)

Methyl + Ethyl Alcohol.			In Methyl + Propyl Alcohol.			In Ethyl + Propyl Alcohol.		
$d_{25}^4$ of Sat. Sol.	Gms. KI per 100 cc. Sat. Sol.	Per cent C <sub>2</sub> H <sub>5</sub> OH in Solvent.	$d_{25}^4$ of Sat. Sol.	Gms. KI per 100 cc. Sat. Sol.	Per cent C <sub>2</sub> H <sub>5</sub> OH in Solvent.	$d_{25}^4$ of Sat. Sol.	Gms. KI per 100 cc. Sat. Sol.	
0.8015	1.55	0	0.9018	13.16	0	0.8015	1.55	
0.8041	1.91	11.11	0.8823	10.96	8.1	0.7983	1.46	
0.8071	2.25	23.8	0.8629	8.54	17.85	0.7991	1.37	
0.8295	4.94	65.2	0.8187	2.62	56.6	0.7988	0.75	
0.8794	10.13	91.8	0.8045	0.60	88.6	0.8022	0.52	
0.8795	10.72	96.6	0.8041	0.58	91.2	0.8027	0.49	
0.8908	11.84	100	0.8041	0.43	95.2	0.8029	0.44	
0.9018	13.16				100	0.8041	0.43	

**SOLUBILITY OF POTASSIUM IODIDE IN ACETAMIDE.**

(Menschutkin, 1908.)

terminations by Synthetic Method.)

m. pt.	Gms. KI per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. KI per 100 Gms. Sat. Sol.	Solid Phase
	0	CH <sub>3</sub> CONH <sub>2</sub>	70	28.75	KI
	6.5	"	85	29.1	"
	12.8	"	100	29.45	"
	17.8	"	130	30.15	"
	21.5	"	145	30.5	"
	26.2	"	160	30.8	"
Interac.	28.4	" + KI	175	31.1	"



SOLUBILITY OF POTASSIUM IODIDE IN ACETONE AND IN PYRIDINE  
(von Laszcynski, 1894; at 25°, Krug and McElroy, 1892.)

Solvent.	Gms. KI per 100 Gms. Solvent at:					
	-2.5°	10°	22°	25°	56°	119°
Acetone	3.08	...	2.38	2.93	1.21	0.1
Pyridine	...	0.26	...	...	...	...

100 gms. glycerol dissolve 40 gms. KI at 15.5°. (Ousadow.)

100 gms. 95% formic acid dissolve 38.2 gms. KI at 18.5°. (Asche.)

100 cc. anhydrous hydrazine dissolve 175 gms. KI at room temp. (Welsh and Broden.)

100 gms. hydroxylamine dissolve 110 gms. KI at 17.5°. (de Bruy.)

100 gms. sat. solution in hydrated lanolin (containing 30% emulsified contain 42.5 gms. KI at 45°. (Klose, 1907.) KI is insoluble in anhydrous lanolin.

SOLUBILITY OF POTASSIUM IODIDE IN SEVERAL SOLVENTS.

(Walden, 1906.)

Solvent.	Formula.	t°.	Sp. Gr. of Solution.	Gms. KI per 100	
				cc. Solution.	Gms. Solvent.
Water	H <sub>2</sub> O	0	1.6699	94.05	56 - 32
Water	H <sub>2</sub> O	25	1.7254	102.70	59 - 54
Methyl Alcohol	CH <sub>3</sub> OH	0	0.8964	11.61	12.95
Methyl Alcohol	CH <sub>3</sub> OH	25	0.9003	13.5-14.3	14.97
Ethyl Alcohol	C <sub>2</sub> H <sub>5</sub> OH	0	0.8085	1.197	1.479
Ethyl Alcohol	C <sub>2</sub> H <sub>5</sub> OH	25	0.7908	1.520	1.922
Glycol	(CH <sub>2</sub> OH) <sub>2</sub>	0	1.3954	45.85	31.03
Glycol	(CH <sub>2</sub> OH) <sub>2</sub>	25	1.3888	47.23	33.01
Acetonitrile	CH <sub>3</sub> CN	0	0.8198	1.852	2.259
Acetonitrile	CH <sub>3</sub> CN	24	0.7938	1.57	2.003
Propionitrile	C <sub>2</sub> H <sub>5</sub> CN	0	0.8005	0.34-0.41	0.0429
Propionitrile	C <sub>2</sub> H <sub>5</sub> CN	25	0.7821	0.32-0.36	0.0404
Benzonitrile	C <sub>6</sub> H <sub>5</sub> CN	25	1.0076	0.051	0.0506
Nitromethane	CH <sub>3</sub> NO <sub>2</sub>	0	1.1627	0.314-0.366	0.315
Nitromethane	CH <sub>3</sub> NO <sub>2</sub>	25	1.1367	0.289-0.349	0.307
Nitrobenzene	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	25	...	0.0019	...
Acetone	(CH <sub>3</sub> ) <sub>2</sub> CO	0	0.8227	1.732	2.105
Acetone	(CH <sub>3</sub> ) <sub>2</sub> CO	25	0.7968	1.038	1.302
Furfural	C <sub>4</sub> H <sub>3</sub> O.CO.H	0	...	15.10	...
Furfural	C <sub>4</sub> H <sub>3</sub> O.CO.H	25	1.2014	5.62	4.04
Benzaldehyde	C <sub>6</sub> H <sub>5</sub> COH	25	1.0446	0.343	0.328
Salicylic Aldehyde	C <sub>6</sub> H <sub>4</sub> .OH.CO.H	0	1.1501	1.257	1.093
Salicylic Aldehyde	C <sub>6</sub> H <sub>4</sub> .OH.CO.H	25	1.1373	0.549	0.483
Anisic Aldehyde	C <sub>6</sub> H <sub>4</sub> .OCH <sub>3</sub> .CO.H	0	1.1223	1.520	1.355
Anisic Aldehyde	C <sub>6</sub> H <sub>4</sub> .OCH <sub>3</sub> .CO.H	25	1.1180	0.720	0.644
Ethyl Acetate	CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub>	25	...	0.0013	...
Methyl Cyanacetate	CH <sub>3</sub> CNCOOCH <sub>3</sub>	0	1.1521	3.256	2.827
Methyl Cyanacetate	CH <sub>3</sub> CNCOOCH <sub>3</sub>	25	1.1358	2.459	2.165
Ethyl Cyanacetate	CH <sub>3</sub> CNCOOC <sub>2</sub> H <sub>5</sub>	25	1.0628	0.989	0.930



# SOLUBILITY OF POTASSIUM IODIDE AT 20° IN SEVERAL SOLVENTS CONTAINING DISSOLVED IODINE.

(Olivari, 1908.)

Solvent.	Gm. Mols. KI per Liter in Solvent Containing:		
	0.5 Gm. Mols. I <sub>2</sub> per Liter.	1.5 Gm. Mols. I <sub>2</sub> per Liter.	2.5 Gm. Mols. I <sub>2</sub> per Liter.
acetic Acid	0.511	1.460	2.080
ethyl Acetate	0.490	1.400	1.980
ethyl Alcohol	0.520	1.220	1.730
toluene	0.414	0.960	1.380
ethylbromide	0.140	0.350	...

# IODINE IN THE SYSTEM POTASSIUM IODIDE—ETHYL ETHER—WATER AT 20°.

(Dunningham, 1914.)

per 100 Gms. Upper Layer.		Gms. per 100 Gms. Lower Layer.			Solid Phase.
H <sub>2</sub> O.	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	KI.	H <sub>2</sub> O.	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> O.	
...	...	59.2	40.8	...	KI
3.9	96.1	0	93	7	None
0.4	99.2	55.6	40.7	3.7	KI
2.2	97.7	25	72.1	2.9	None

# DISTRIBUTION OF POTASSIUM IODIDE BETWEEN WATER AND:

benzene at 18°. (Dawson, 1908.) Phenol at Room Temp. (Riesenfeld, 1902.)

Gms. KI per Liter.		Dist. Ratio.	Gms. KI per 100 cc.		Dist. Ratio.
h <sub>2</sub> Layer.	H <sub>2</sub> O Layer.		C <sub>6</sub> H <sub>5</sub> OH Layer.	Aq. Layer.	
0.114	6.05	5300	0.052	0.725	13.2
0.108	6.05	5600	0.197	2.42	12.3
			2.09	30.7	14.7

g-point data for KI + K<sub>2</sub>SO<sub>4</sub> and KI + NaCl are given by Ruff and (1903). Results for KI + AgI are given by Sandonnini (1912a). Results for SO<sub>2</sub> are given by Walden and Centnerszwer (1903).

# POTASSIUM IODOMERCURATE (Thoulet Solution).

solution at 22.9°, prepared by adding KI and HgI<sub>2</sub> in excess to water, 8.66% K, 22.49% Hg, 52.58 (57.7) % I and 10.97 (11.15)% H<sub>2</sub>O, according to 0.22 mol. alkali, 0.11 mol. Hg and 0.45 mol. I. (Dubois, 1905.)

# POTASSIUM MOLYBDATE K<sub>2</sub>MoO<sub>4</sub>

# SOLUBILITY OF POTASSIUM MOLYBDATE IN AQUEOUS SOLUTIONS OF POTASSIUM SULFATE AT 25° AND VICE VERSA.

(Amadori, 1912a).

Gms. per 100 Gms. H <sub>2</sub> O.		Gms. per 100 Gms. H <sub>2</sub> O.	
K <sub>2</sub> SO <sub>4</sub> .	K <sub>2</sub> MoO <sub>4</sub> .	K <sub>2</sub> SO <sub>4</sub> .	K <sub>2</sub> MoO <sub>4</sub> .
0	184.6	1.50	99.40
0.46	180.7	2.13	45.89
0.72	177	3.95	17.48
0.98	127.2	8.55	4.73
1.27	107.5	12.10	0

g-point data for K<sub>2</sub>MoO<sub>4</sub> + K<sub>2</sub>SO<sub>4</sub>, K<sub>2</sub>MoO<sub>4</sub> + K<sub>2</sub>WO<sub>4</sub> and K<sub>2</sub>MoO<sub>4</sub> + H<sub>2</sub> are given by Amadori (1913).

# POTASSIUM NITRATE KNO<sub>3</sub>.

# SOLUBILITY ICE CURVE AND SUPERSOLUBILITY ICE CURVE.

(Jones, 1908.)

Gms. KNO <sub>3</sub> per 100 Gms. H <sub>2</sub> O.		t° of Cryst.	Gms. KNO <sub>3</sub> per 100 Gms. H <sub>2</sub> O.	
Solubility Ice Curve.	Supersolubility Ice Curve.		Solubility Ice Curve.	Supersolubility Ice Curve.
3.336	1.011	-3	...	5.762
7.582	3.538	-4	...	8.694
11.62	5.56	-5	...	11.12
		-5.3*	...	11.82

\* Cryohydrate.



# POTASSIUM NITRATE

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## SOLUBILITY IN WATER.

(Mulder; Andrae, 1884; Gerardin, 1865; Etard, 1894; Ost, 1878; at 31.25°, Köhler, 1897; Euler and Tilden and Shenstone, 1884; Berkeley, 1904.)

Average Curve.

t°.	Gms. KNO <sub>3</sub> per 100 Gms.		t°.	Gms. KNO <sub>3</sub> per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	13.3	11.7	70	138	58.0
10	20.9	17.3	80	169	62.8
20	31.6	24.0	90	202	66.9
25	37.3	27.2	100	246	71.1
30	45.8	31.4	110	300	75.0
40	63.9	39.0	120	394	79.8
50	85.5	44.0	125	493	83.1
60	110.0	52.0			

The very carefully determined figures of Berkeley are as follows:

t°.	d <sub>4</sub> of Sat. Sol.	Gms. KNO <sub>3</sub> per 100 Gms. H <sub>2</sub> O.	t°.	d <sub>4</sub> of Sat. Sol.	Gms. KN 100 Gms
0.40	1.0817	13.43	60.05	1.3903	111.
14.90	1.1389	25.78	76	1.4700	156.
30.80	1.2218	47.52	91.65	1.5394	210.
44.75	1.3043	74.50	114 b. pt.	1.6269	311.

1000 gms. H<sub>2</sub>O dissolve 384.48 gms. KNO<sub>3</sub> at 25°. (Armstrong and Eyre, 15  
One liter sat. solution in water contains 2.8 mols. = 283.11 gms. KNO<sub>3</sub> a  
(Rosenheim and Weinheber, 15

Recent determinations of the solubility of potassium nitrate in water, agree satisfactorily with the above data, are given by Chugaev and Khlopkin (19

## SOLUBILITY OF MIXTURES OF POTASSIUM NITRATE AND BAR NITRATE IN WATER.

(Euler — Z. physik. Ch. 49, 313, '04.)

t°.	Sp. Gr. of Sat. Solution.	Grams per 100 Grams H <sub>2</sub> O.	
17	1.120	13.26 KNO <sub>3</sub> +	6.31 Ba(NO <sub>3</sub> ) <sub>2</sub>
21.5	...	17.00 " +	7.58 "
30	1.191	24.04 " +	9.99 "
50	...	49.34 " +	18.09 "

## SOLUBILITY OF POTASSIUM NITRATE IN AQUEOUS SOLUTIONS OF NITRIC ACID AT 0°.

(Engel — Compt. rend. 104, 913, '87.)

Sp. Gr. of Solutions.	Equivalents per 10 cc. Solution.		Grams per 100 cc. Solution.	
	12.5 KNO <sub>3</sub>	0 HNO <sub>3</sub>	12.65 KNO <sub>3</sub>	0.00 HNO <sub>3</sub>
1.079	12.5	0	12.65	0.00
...	9.9	5.87	10.02	3.71
1.093	8.28	13.2	8.38	8.38
1.117	7.4	21.55	7.49	13.58
1.144	7.4	31.1	7.49	19.47
1.202	7.6	48.0	7.68	30.04
1.289	10.3	68.0	10.42	42.86
1.498	28.3	120.5	28.64	75.95

Freezing-point data for KNO<sub>3</sub> + HNO<sub>3</sub> are given by Denby (1918).



# **SOLUBILITY OF POTASSIUM NITRATE AND OF ACID POTASSIUM NITRATES IN NITRIC ACID.**

(Groschuff — Ber. 37, 1490, '04.)

**NOTE.**—Determinations made by the so-called thermometric method, i.e., by observing the temperature of the disappearance of the separated, finely divided solid from solutions of known concentration.

t°.	Gms. per 100 Gms. Solution.		Solid Phase.	t°.	Gms. per 100 Gms. Solution.		Solid Phase.
	KNO <sub>3</sub> .	HNO <sub>3</sub> .			KNO <sub>3</sub> .	HNO <sub>3</sub> .	
- 6	24.4	75.41	KNO <sub>3</sub> ·HNO <sub>3</sub> (?)	22.5	47.2	52.93	KNO <sub>3</sub> ·HNO <sub>3</sub>
+ 14	32.6	67.42	" (stabil)	23.5	47.8	52.11	" (stabil)
17	34.8	65.04	"	25.5	48.6	51.46	"
19.5	37.2	62.90	"	27.0	49.4	50.78	"
22	44.5	55.46	"	29.0	50.1	49.94	KNO <sub>3</sub> ·HNO <sub>3</sub>
21.5	47.8	52.11	KNO <sub>3</sub> ·HNO <sub>3</sub> (?)	30.5	50.9	49.15	" (labil)
21.5	48.6	51.46	" (labil)	21.0	49.4	50.78	KNO <sub>3</sub> (labil)
20	50.9	49.15	"	39.0	50.9	49.15	" (stabil)
- 4	37.2	62.81	KNO <sub>3</sub> ·HNO <sub>3</sub>	50	51.7	48.32	
- 16.5	44.5	55.46	" (labil)				

(?) Solution in HNO<sub>3</sub>.

(?) Solution in KNO<sub>3</sub>.

## **CONDUCT OF ACID POTASSIUM NITRATE TOWARDS WATER.**

t°.	Gms. per 100 Gms. Solution.		Solid Phase.	t°.	Gms. per 100 Gms. Solution.		Solid Phase.
	KNO <sub>3</sub> .	HNO <sub>3</sub> .			KNO <sub>3</sub> .	HNO <sub>3</sub> .	
22	44.5	55.5	KNO <sub>3</sub> ·HNO <sub>3</sub>	50	38.7	48.3	KNO <sub>3</sub>
20.5	44.1	55.0	"	61	36.0	44.8	"
18	43.8	54.5	"	63	34.5	43.0	"
12	43.0	53.6	"	60.5	30.9	39.5	"
6	42.3	52.7	"	56	27.6	34.4	"
0	41.6	51.8	"	43	20.8	25.9	"
12	41.3	51.4	KNO <sub>3</sub>	17	11.7	14.6	"
22	40.9	51.0	"	-5	5.54	6.91	"
40	39.9	49.8	"				

## **SOLUBILITY OF MIXTURES OF POTASSIUM NITRATE AND POTASSIUM CHLORIDE IN WATER.**

(Etard — Ann. chim. phys. [7] 3, 283, '94; at 20°, Rüdorff — Ber. 6, 482, '73; Nicol — Phil. Mag. [5] 31, 385, '91.)

t°.	Gms. per 100 Gms. Solution.		t°.	Gms. per 100 Gms. Solution.		t°.	Gms. per 100 Gms. Solution.	
	KNO <sub>3</sub> .	KCl.		KNO <sub>3</sub> .	KCl.		KNO <sub>3</sub> .	KCl.
0	5.0	20.0	30	16.0	21.2	70	39.5	17.5
10	8.0	20.8	40	21.0	21.0	80	45.5	15.8
20	12.6	21.2	50	27.0	20.0	100	57.5	11.6
25	14.0	21.3	60	33.5	19.0	120	69.0	7.7



SOLUBILITY OF POTASSIUM NITRATE IN AQUEOUS SOLUTIONS OF:  
(Touren — Compt. rend. 131, 259, '00.)

Potassium Carbonate.

Potassium Bi Carbonate.

Results at 14.5°.				Results at 14.5°.			
Mols. per Liter.		Gms. per Liter.		Mols. per Liter.		Gms. per Liter.	
K <sub>2</sub> CO <sub>3</sub>	KNO <sub>3</sub>	K <sub>2</sub> CO <sub>3</sub>	KNO <sub>3</sub>	KHCO <sub>3</sub>	KNO <sub>3</sub>	KHCO <sub>3</sub>	KNO <sub>3</sub>
0.0	2.228	0.0	225	0.0	2.33	0.0	236
0.48	1.85	66.4	188	0.39	2.17	39.0	220
1.25	1.39	172.9	141	0.76	2.03	76.0	205
2.58	0.86	356.9	87	1.16	1.92	116	194
3.94	0.64	544.9	65	1.55	1.81	155	183
Results at 25°.				Results at 25°.			
0.0	3.217	0.0	326	0.0	3.28	0.0	331
0.59	2.62	81.6	265	0.89	2.84	89	287
1.35	1.97	186.7	199	1.33	2.65	133	268
2.10	1.46	290.5	148	1.91	2.45	191	249
2.70	1.14	373.6	115				
3.58	0.79	495.1	80				

SOLUBILITY OF POTASSIUM NITRATE IN AQUEOUS SOLUTIONS OF POTASSIUM CARBONATE AT 24.2°.  
(Kremann and Zitek, 1909.)

Gms. per 1000 Gms. H <sub>2</sub> O.		Solid Phase.	Gms. per 1000 Gms. H <sub>2</sub> O.		Solid Phase.
KNO <sub>3</sub>	K <sub>2</sub> CO <sub>3</sub>		KNO <sub>3</sub>	K <sub>2</sub> CO <sub>3</sub>	
376.8	0	KNO <sub>3</sub>	73	688.1	KNO <sub>3</sub>
285	130.3	"	38.8	878.3	"
161.7	348.4	"	31.1	1112.2	"
141.8	371.9	"			

1000 gms. H<sub>2</sub>O containing 1 mol. KCl (101.11 gms.) dissolve 324.85 gms. at 25°.

(Armstrong and Eyring)

Data for the system potassium nitrate, potassium sulfate, water at given by Massink (1916, 1917).

SOLUBILITY OF MIXTURES OF POTASSIUM NITRATE AND POTASSIUM SULPHATE IN WATER.

(Euler — Z. physik. Ch. 49, 313, '04.)

t°.	Sp. Gr. of Sat. Solution.	Grams per 100 Grams Water.			
		KNO <sub>3</sub>		K <sub>2</sub> SO <sub>4</sub>	
15	1.165	24.12	5.65		
20	...	30.10	5.58		
25	1.210	36.12	5.58		

SOLUBILITY OF MIXTURES OF POTASSIUM NITRATE AND SODIUM CHLORIDE IN WATER.

(Etard — Ann. chim. phys. [7] 3, 283, '94; the older determinations of Rüdorff, Karsten, agree well with those of Etard.)

t°.	Gms. per 100 Gms. Solution.		t°.	Gms. per 100 Gms. Solution.		t°.	Gms. per 100 Gms. Solution.	
	KNO <sub>3</sub>	NaCl		KNO <sub>3</sub>	NaCl		KNO <sub>3</sub>	NaCl
0	13	24	40	30.5	19	120	73	
10	16	23	50	36	17	140	77	
20	20	22	60	42.5	15	160	79.5	
25	23	21.5	80	55	12	170	80.5	
30	25	20.5	100	67	9.5			



in  $\text{H}_2\text{O}$ , simultaneously sat. with potassium nitrate and sodium chloride in 41.14 gms.  $\text{KNO}_3$  + 38.53 gms.  $\text{NaCl}$  at  $25^\circ$  and 168.8 gms.  $\text{KNO}_3$  gms.  $\text{NaCl}$  at  $80^\circ$ . (Soch, 1898.)

UTILITY OF POTASSIUM NITRATE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE AND VICE VERSA. (Leather and Mukerji, 1913.)

Results at $20^\circ$ .			Sp. Gr. Sat. Sol.	Results at $30^\circ$ .		
Gms. per 100 $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	Solid Phase.		Gms. per 100 $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	Solid Phase.
$\text{KNO}_3$ .	$\text{NaCl}$ .			$\text{KNO}_3$ .	$\text{NaCl}$ .	
31.49	0	$\text{KNO}_3$	1.261	46.48	9.82	$\text{KNO}_3$
33.41	9.94	"	1.302	47.08	20.18	"
34.93	19.44	"	1.343	47.24	29.86	"
36.41	29.46	"	1.372	49.24	38.72	" + $\text{NaCl}$
37.30	37.73	" + $\text{NaCl}$	1.342	38.36	38.55	$\text{NaCl}$
31.41	37.57	$\text{NaCl}$	1.298	25.32	38.23	"
19.56	37.51	"	1.258	12.15	37.38	"
9.76	36.73	"	1.202	...	36.30	"
Results at $40^\circ$ .			Sp. Gr. Sat. Sol.	Results at $91^\circ$ .		
Gms. per 100 $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	Solid Phase.		Gms. per 100 $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	Solid Phase.
$\text{KNO}_3$ .	$\text{NaCl}$ .			$\text{KNO}_3$ .	$\text{NaCl}$ .	
64.74	0	$\text{KNO}_3$	1.552	202.8	0	$\text{KNO}_3$
64.66	11.32	"	1.573	204.2	12.81	"
64.05	23.41	"	1.601	208.1	28.45	"
64.13	35.08	"	1.645	213.3	37.92	"
64.77	38.79	" + $\text{NaCl}$	1.660	218.8	39.08	" + $\text{NaCl}$
52.81	39.51	$\text{NaCl}$	1.607	175.8	40.87	$\text{NaCl}$
34.98	38.98	"	1.517	126.9	44.33	"
17.33	37.74	"	1.378	57.53	42.90	"

higher temperatures, results for  $\text{NaNO}_3$  in certain solutions are reported.

UTILITY OF POTASSIUM NITRATE IN AQUEOUS SOLUTIONS OF SODIUM NITRATE AND VICE VERSA. (Leather and Mukerji, 1913.)

Results at $30^\circ$ .			Results at $40^\circ$ .			Results at $91^\circ$ .		
Gms. per 100 $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	Sp. Gr. Sat. Sol.	Gms. per 100 $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	Sp. Gr. Sat. Sol.	Gms. per 100 $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	Solid Phase in Each Case.
$\text{KNO}_3$ .	$\text{NaNO}_3$ .		$\text{KNO}_3$ .	$\text{NaNO}_3$ .		$\text{KNO}_3$ .	$\text{NaNO}_3$ .	
15.73	25.90	1.358	63.21	23.85	1.615	200.8	43.4	$\text{KNO}_3$
17.25	52.53	1.428	63.86	49.79	1.674	207.2	92.90	"
50.93	79.27	1.505	66.44	79.46	1.751	229.5	156.2	"
54.34	103.3	1.570	74.06	116.2	1.790	251.8	206.5	" + $\text{NaNO}_3$
17.67	103.1	1.573	68.72	116.7	1.774	211.7	200	$\text{NaNO}_3$
30.25	101.6	1.526	43.92	112.2	1.695	128.5	186	"
14.30	99.10	1.476	20.33	109.9	1.610	55.75	173.1	"
0	95.90	1.421	0	105.2	1.521	0	160.8	"

at  $20^\circ$  are also given.

UTILITY OF POTASSIUM NITRATE IN AQUEOUS SOLUTIONS OF SODIUM NITRATE AND VICE VERSA AT  $20^\circ$ .

armelly and Thomson — J. Ch. Soc. 53, 782, '88; Nicol — Phil. Mag. 31, 369, '91.)

$\text{NaNO}_3$  in Aq.  $\text{NaNO}_3$  Solutions.  $\text{NaNO}_3$  in Aq.  $\text{KNO}_3$  Solutions.

Grams per 100 Grams $\text{H}_2\text{O}$ .		Grams per 100 Grams $\text{H}_2\text{O}$ .	
$\text{NaNO}_3$ .	$\text{KNO}_3$ .	$\text{KNO}_3$ .	$\text{NaNO}_3$ .
0	31.6	0	88
10	30.5	10	90
20	31.0	20	92
40	33.0	25	93
60	35.5	30	94
80	41.0	35	96



SOLUBILITY OF POTASSIUM NITRATE IN AQUEOUS SOLUTIONS OF SODIUM NITRATE AND VICE VERSA AT 10° AND AT 24.2°.  
(Kremann and Zitek, 1909.)

t°.	Gms. per 1000 Gms. H <sub>2</sub> O.		Solid Phase.	t°.	Gms. per 1000 Gms. H <sub>2</sub> O.		Solid Phase.
	KNO <sub>3</sub> .	NaNO <sub>3</sub> .			KNO <sub>3</sub> .	NaNO <sub>3</sub> .	
10	208.9	0	KNO <sub>3</sub>	24.2	422	931.3	KNO <sub>3</sub>
10	301.9	848.3	" + NaNO <sub>3</sub>	24.2	437	1019	" + NaNO <sub>3</sub>
10	0	805	NaNO <sub>3</sub>	24.2	123.6	910.6	NaNO <sub>3</sub>
24.2	377.3	0	KNO <sub>3</sub>	24.2	0	913	"
24.2	390	346.7	"				

SOLUBILITY OF POTASSIUM NITRATE IN AQUEOUS SOLUTIONS OF SILVER NITRATE AT 30° AND VICE VERSA.  
(Schreinemakers, 1908-09.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
KNO <sub>3</sub> .	AgNO <sub>3</sub> .		KNO <sub>3</sub> .	AgNO <sub>3</sub> .	
31.3	0	KNO <sub>3</sub>	17.38	57.85	AgNO <sub>3</sub> .KNO <sub>3</sub>
30.45	11.51	"	13.44	65.08	"
29.22	23.59	"	11.22	69.01	" + AgNO <sub>3</sub>
26.58	39.09	"	5.53	71.65	AgNO <sub>3</sub>
25.02	46.38	" + AgNO <sub>3</sub> .KNO <sub>3</sub>	0	73	"

SOLUBILITY OF MIXTURES OF POTASSIUM NITRATE AND SILVER NITRATE IN WATER.  
(Etard, 1894.)

t°.	Gms. per 100 Gms. Sol.		t°.	Gms. per 100 Gms. Sol.		t°.	Gms. per 100 Gms. Sol.	
	KNO <sub>3</sub> .	AgNO <sub>3</sub> .		KNO <sub>3</sub> .	AgNO <sub>3</sub> .		KNO <sub>3</sub> .	AgNO <sub>3</sub> .
0	13.5	43	30	26.8	49.4	80	36.2	55
10	19	44.7	40	29.6	51.5	100	38.3	55
20	23	47	50	32	54	120	40	55
25	25	48	60	33.5	54.8	140	41.5	55

SOLUBILITY OF MIXED CRYSTALS OF POTASSIUM NITRATE AND SILVER NITRATE IN WATER AT 25°.  
(Herz, 1905; Fock, 1897.)

Gms. per Liter.		Mg. Mols. per Liter.		Mol. Per cent AgNO <sub>3</sub> in Solution.	Mol. Per cent AgNO <sub>3</sub> in Solid Phase.
AgNO <sub>3</sub> .	KNO <sub>3</sub> .	AgNO <sub>3</sub> .	KNO <sub>3</sub> .		
45.9	321.8	270	3180	7.83	0.2896
110.7	322.6	651.3	3184	16.96	0.6006
176.8	333.7	1040	3298	23.97	0.9040
259.6	364	1528	3597	29.81	1.054
365.6	456.4	2151	4511	32.28	1.604
507.9	387.2	2988	3816	43.85	2.439
745.9	398.6	4388	3960	52.70	8.294

SOLUBILITY OF POTASSIUM NITRATE IN AQUEOUS SOLUTIONS OF STRONTIUM NITRATE AND VICE VERSA AT 20° AND AT 40°.  
(Findlay, Morgan and Morris, 1914.)

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	KNO <sub>3</sub> .	Sr(NO <sub>3</sub> ) <sub>2</sub> .			KNO <sub>3</sub> .	Sr(NO <sub>3</sub> ) <sub>2</sub> .	
20	22.90	5.49	KNO <sub>3</sub>	20	12.65	41.12	Sr(NO <sub>3</sub> ) <sub>2</sub>
20	21.70	9.17	"	20	10	40.70	"
20	21.01	17.10	"	40	30.26	23.70	KNO <sub>3</sub>
20	19.60	31.24	"	40	26.90	38.52	" + Sr(NO <sub>3</sub> ) <sub>2</sub>
20	19.49	34.91	"	40	22.50	40.22	Sr(NO <sub>3</sub> ) <sub>2</sub>
20	19.69	39.56	" + Sr(NO <sub>3</sub> ) <sub>2</sub> .4H <sub>2</sub> O	40	11.19	44.19	"
20	17.56	40.37	Sr(NO <sub>3</sub> ) <sub>2</sub> .4H <sub>2</sub> O	40	0	47.7	"

1000 gms. H<sub>2</sub>O, simultaneously saturated with both salts, contain 552 KNO<sub>3</sub> + 1074 gms. Sr(NO<sub>3</sub>)<sub>2</sub> at 25°.  
(LeBlanc and Noy)



STABILITY OF MIXED CRYSTALS OF POTASSIUM NITRATE AND THALLIUM NITRATE IN WATER AT 25°.

Grams per Liter.		Mg. Mols. per Liter.		Mol. per cent TlNO <sub>3</sub> in Solution.	Sp. Gr. of Solutions.	Mol. per cent TlNO <sub>3</sub> in Solid Phase.
TlNO <sub>3</sub>	KNO <sub>3</sub>	TlNO <sub>3</sub>	KNO <sub>3</sub>			
0.00	351.0	0.0	3468.2	0.00	1.2632	0.00
2.37	329.0	8.9	3251.5	0.43	1.1903	0.08
6.15	332.4	23.1	3285.1	0.70	1.1956	0.20
17.64	333.7	66.3	3298.1	1.97	1.2050	0.57
49.74	333.3	186.9	3294.4	5.37	1.2196	1.78
63.60	321.0	239.0	3172.4	7.01	1.2436	2.19
86.18	330.5	323.8	3265.8	9.02	1.2617	2.77
123.8	428.3	465.2	4232.6	9.90	1.2950	6.00
101.3	245.1	380.6	2423.3	13.58	1.2050	27.04
116.1	0.0	463.1	0.0	100.00	1.0964	93.33
						100.00

STABILITY OF POTASSIUM NITRATE IN AQUEOUS ALCOHOL SOLUTIONS.  
(Gerardin — Ann. chim. phys. [4] 5, 151, '65.)

Grams KNO <sub>3</sub> per 100 Grams Aqueous Alcohol of Sp. Gr.:							
0.9904 = 1.5 Wt. %.	0.9843 = 9.35 Wt. %.	0.9793 = 13.5 Wt. %.	0.9726 = 19.1 Wt. %.	0.9571 = 30 Wt. %.	0.939 = 40 Wt. %.	0.867 = 60 Wt. %.	0.849 = 90 Wt. %.
17	13	10	7	4.5	3	1	0.2
22.5	18.5	14.5	10	6.2	4.5	1.6	0.3
24	20	16	11	7.0	5	2	0.3
29	24.5	20	13.5	9.0	6.5	2.5	0.4
36	30	25	17	11.5	8	3.0	0.5
52	43	36	27	16.5	11	4	0.6
72	61	50	38	23.0	16	6	0.7
93	79	69	52	31.0	21	8	1.1

STABILITY OF POTASSIUM NITRATE IN AQUEOUS ALCOHOL AT 18°  
(Bodländer — Z. physik. Ch. 7, 316, '91.)

Gr. of solution.	Gms. per 100 cc. Solution.			Sp. Gr. of Solution.	Gms. per 100 cc. Solution.		
	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	KNO <sub>3</sub> .		C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	KNO <sub>3</sub> .
1480	...	89.80	25.0	1.0120	23.33	69.81	8.06
1085	3.30	87.44	20.11	0.9935	28.11	64.74	6.50
010	5.24	86.26	18.60	0.9585	37.53	54.21	4.11
805	8.69	83.18	16.18	0.9450	42.98	48.15	3.37
'55	9.06	83.10	15.39	0.9050	51.23	27.32	1.95
'55	14.08	77.93	14.54	0.8722	61.65	24.74	0.83
90	16.27	76.36	12.27	0.8375	69.60	13.95	0.20
75	19.97	72.93	10.8				

SOLUBILITY OF POTASSIUM NITRATE IN DILUTE ETHYL ALCOHOL AT 25°.  
(Armstrong and Eyre, 1910-11.)

Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	Gms. KNO <sub>3</sub> per 100 Gms. Sat. Solution.
0	27.77
1.14	26.69
2.25	25.79
4.41	23.81



# POTASSIUM NITRATE

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## SOLUBILITY OF POTASSIUM NITRATE IN AQUEOUS ALCOHOL AND IN AQUEOUS ACETONE.

(Batarick, 1896.)

Wt. Per cent Alcohol.	In Aqueous Alcohol.		Wt. Per cent Acetone.	Gms. KNO <sub>3</sub> per 100 Gms. Solvent.
	Gms. KNO <sub>3</sub> per 100 Gms. Aq. Alcohol.			
	At 30°.	At 40°.		
0	45.6	64.5	0	64.5
8.25	32.3	47.1	8.5	51.3
17	22.4	33.3	16.8	38.9
25.7	15.1	24.1	25.2	22.8
35	11.4 (34.4°)	16.7	34.3	24.7
44.9	7	11.6 (44°)	44.1	17
54.3	4.5	7.2 (55°)	53.9	11.9
65	2.7	4.4	64.8	7.1
75.6	1.3	2 (76.3°)	76	3
88	0.4	0.6 (88.5°)	87.6	0.7

100 gms. H<sub>2</sub>O saturated with sugar and KNO<sub>3</sub> dissolve 224.7 gms. sugar + 41.9 gms. KNO<sub>3</sub>, or 100 gms. of the saturated solution contain 61.36 gms. sugar + 11.45 gms. KNO<sub>3</sub> at 31.25°.  
(Köhler, 1891.)

## SOLUBILITY OF POTASSIUM NITRATE IN AQUEOUS SOLUTIONS OF METHYL ALCOHOL, ETHYL ALCOHOL AND MIXTURES OF THE TWO AT 30°.

(Schreinemakers, 1908-09.)

In Aq. CH <sub>3</sub> OH.		In Aq. C <sub>2</sub> H <sub>5</sub> OH.		In Aq. (CH <sub>3</sub> OH + C <sub>2</sub> H <sub>5</sub> OH). <sup>a</sup>	
Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.	
CH <sub>3</sub> OH.	KNO <sub>3</sub> .	C <sub>2</sub> H <sub>5</sub> OH.	KNO <sub>3</sub> .	(CH <sub>3</sub> OH + C <sub>2</sub> H <sub>5</sub> OH)	KNO <sub>3</sub> .
0	31.3	10.1	20.7	0	31.3
7.8	23.3	23.8	12.1	12.7	18.9
17.3	16.3	32.2	9	29.2	12.8
27.8	11.2	43.1	6.1	41	6.7
38.4	7.7	56.9	3.3	47.8	5.1
57	3.8	76.8	0.88	56.4	3.5
98.58	0.43	92.3	0.15	74.8	1.2

<sup>a</sup> The mixture contained 51.7% CH<sub>3</sub>OH and 48.3% C<sub>2</sub>H<sub>5</sub>OH.

100 gms. trichlorethylene dissolve 0.01 gm. KNO<sub>3</sub> at 15°. (Wester and Bruns, 1904.)  
100 cc. anhydrous hydrazine dissolve 14 gms. KNO<sub>3</sub> at room temp. (Welsh and Broderick, 1904.)

100 gms. aq. 40 weight % C<sub>2</sub>H<sub>5</sub>OH, simultaneously saturated with salts, dissolve 13.74 gms. KNO<sub>3</sub> + 15.78 gms. NaCl at 25°. (Schreinemakers, 1908-09.)

## SIMULTANEOUS SOLUBILITY OF POTASSIUM NITRATE AND SILVER NITRATE IN AQUEOUS 51.6 PER CENT C<sub>2</sub>H<sub>5</sub>OH AT 30°.

(Schreinemakers, 1908-09.)

Gms. per 100 Gms. Sat. Solution.		Solid Phase.
KNO <sub>3</sub> .	AgNO <sub>3</sub> .	
4.8	0	KNO <sub>3</sub>
4.55	5.15	"
4.11	16.47	"
4.26	21.28	" + AgNO <sub>3</sub> ·KNO <sub>3</sub>
2.62	36.94	AgNO <sub>3</sub> ·KNO <sub>3</sub> + AgNO <sub>3</sub>
0	37	AgNO <sub>3</sub>

Fusion-point data (solubilities, see footnote, p. 1), are given for KNO<sub>3</sub> by Meneghini (1912); for KNO<sub>3</sub> + AgNO<sub>3</sub> by Usso (1904); for KNO<sub>3</sub> + NaNO<sub>3</sub> by Carveth (1898) and by Hissink (1900); for KNO<sub>3</sub> + Sr(NO<sub>3</sub>)<sub>2</sub> and + NaNO<sub>3</sub> by Harkins and Clark (1915); for KNO<sub>3</sub> + NaNO<sub>3</sub> by Van Eyk (1899, 1905).



**M NITRITE  $\text{KNO}_2$ .****SOLUBILITY IN WATER.**  
(Oswald, 1912, 1914.)

Gms. $\text{KNO}_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{KNO}_2$ per 100 Gms. Sat. Sol.	Solid Phase.
16.1	Ice	+ 17.5	74.5*	$\text{KNO}_2$
24.1	"	25	75.75	"
40.2	"	40	77	"
50.1	"	55	77.5	"
61.7	"	75	78.5	"
69.8	"	100	80.5	"
Autec. 71.8	" + $\text{KNO}_3$	111	80.7	"
73.2	$\text{KNO}_3$	119	81.15	"
73.6	"	125	81.8	"

\*  $d_{17.4} = 1.6464$ .

$\text{H}_2\text{O}$  dissolve about 300 gms.  $\text{KNO}_2$  at  $15.5^\circ$ . (Divers, 1899.)  
 138.5 gms.  $\text{KNO}_2$  per 100 gms.  $\text{H}_2\text{O}$  at  $15^\circ$ , given by von Niemen-  
 on Roszkowski (1897), is evidently low.

**OF MIXTURES OF POTASSIUM NITRITE AND OF SILVER NITRITE IN  
WATER.**  
(Oswald, 1914.)

at 13.5°.		Results at 25°.		Solid Phase in Each Case.
Gms. H <sub>2</sub> O.	AgNO <sub>3</sub> .	Gms. per 100 Gms. H <sub>2</sub> O.		
		KNO <sub>3</sub> .	AgNO <sub>3</sub> .	
2.36		23.1	5.3	AgNO <sub>3</sub> + K <sub>2</sub> Ag <sub>2</sub> (NO <sub>3</sub> ) <sub>4</sub> ·H <sub>2</sub> O
26.3		279	39.3	KNO <sub>3</sub> + K <sub>2</sub> Ag <sub>2</sub> (NO <sub>3</sub> ) <sub>4</sub> ·H <sub>2</sub> O

layers obtained by mixing an equal volume or more of 96% ethyl  
 a nearly saturated aqueous solution of  $\text{KNO}_2$ , the lower contains  
 and the upper, alcoholic, 6.9%. With methyl alcohol there is no  
 to two layers. (Donath, 1911.)

**N OXALATE  $\text{K}_2\text{C}_2\text{O}_4 \cdot 4\text{H}_2\text{O}$ .****Y OF MIXTURES OF POTASSIUM OXALATE AND OXALIC ACID IN  
WATER AT  $25^\circ$ .**  
(Foote and Andrew, 1905.)

ms. Solution. $\text{K}_2\text{C}_2\text{O}_4$ .	Mols. per 100 Mols. $\text{H}_2\text{O}$ .		Solid Phase.
	$\text{H}_2\text{C}_2\text{O}_4$ .	$\text{K}_2\text{C}_2\text{O}_4$ .	
...	2.274	...	$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$
0.04	2.302	0.005	$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} + \text{H}_2\text{K}(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$
0.13	2.046	0.016	Double salt $\text{H}_2\text{K}(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$
0.63	0.707	0.071	
4.26	0.440	0.495	$\text{H}_2\text{K}(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O} + \text{HKC}_2\text{O}_4$
11.50	0.266	1.427	Double salt $\text{HKC}_2\text{O}_4$
16.93	0.240	2.235	
21.08	0.221	2.928	$\text{HKC}_2\text{O}_4 + \text{H}_2\text{K}_2(\text{C}_2\text{O}_4)_3 \cdot 2\text{H}_2\text{O}$
21.49	0.211	2.998	Double salt $\text{H}_2\text{K}_2(\text{C}_2\text{O}_4)_3 \cdot 2\text{H}_2\text{O}$
23.52	0.169	3.361	
24.88	0.153	3.617	
27.52	0.122	4.14	$\text{H}_2\text{K}_2(\text{C}_2\text{O}_4)_3 \cdot 2\text{H}_2\text{O} + \text{K}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$
27.40	...	4.09	$\text{K}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$



EQUILIBRIUM IN THE SYSTEM POTASSIUM OXALATE, OXALIC ACID,  
0°, 30° AND 60°.

(Koppel and Cahn, 1908.)

Results at 0°.		Results at 30°.		Results at 60°.		Solid Phase is
Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.		
$C_2O_3$	$K_2O$	$C_2O_3$	$K_2O$	$C_2O_3$	$K_2O$	
2.72	...	9.97	...	24.75	...	$H_2C_2O_4 \cdot 2H_2O$
2.91	0.226*	10.15	0.10	...	...	"
2.985	0.342*	...	...	...	...	"
2.827	0.125	10.23	0.34	25.70	0.46	" + $KH_2C$
2.345	0.145	...	...	...	...	"
1.471	0.195	7.28	0.33	25.80	0.54	$KH_2(C_2O_4)_{2-1}$
0.823	0.240	4	0.41	22.06	0.58	"
0.799	0.454	3.08	0.50	20.17	0.67	"
1.173	0.785	2.38	1.002	14.25	0.90	"
1.381	0.962	2.98	1.79	9.82	1.48	"
1.545	1.155	...	...	6.95	2.244	"
1.666	1.273	4.24	2.76	9.17	5.60	" + $KHC_2O_4$
1.754	1.479	4.26	3.38	8.81	6.37	$KHC_2O_4$
2.627	2.858	5.44	5.43	10.17	10	"
3.772	4.422	6.66	7.27	12.36	13.40	"
4.292	5.161	8.64	10.05	14.10	16	"
4.975	6.088	10.03	12.01	15.35	17.80	"
5.652	7	10.80	12.94	16.07	18.89	" + $(K_2C_2O_4)_2 \cdot H_2C$
6.27	7.87	11.47	14.13	16.51	19.59	$(K_2C_2O_4)_2 \cdot H_2C$
7.63	9.72	12.16	15.11	16.80	20.10	"
8.66	11.14	12.32	15.37	16.95	20.34	"
9.055	11.58	12.90	16.23	17.14	20.70	" + $K_2C_2O_4$
8.826	11.52	12.36	16.14	16.71	20.41	$K_2C_2O_4$
5.215	12.33	8.52	15.03	15.94	20.11	
2.23	14.80	4.53	15.55	15.06	19.66	
1.245	16.82	1.87	18.17	8.82	19.25	
0.871	18.4	0.74	22.32	2.04	23.09	
0.511	20.91	...	...	0.434	29	
0.325	23.30	...	...	0.365	31.40	
0	41.3†	0	46.79	0	51.34	KOI

\* Supersaturated.

† About.

EQUILIBRIUM IN THE SYSTEM POTASSIUM OXALATE, OXALIC ACID  
AT 25°.

(Hartley, Drugman, Vlieland and Bourdillon, 1913.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase
$C_2O_3$	$K_2O$		$C_2O_3$	$K_2O$	
8.29	0	$H_2C_2O_4 \cdot 2H_2O$	3.079	2.052	$KH_2(C_2O_4)_{2-1} \cdot 2H_2O$
8.278	0.045	" + $KH_2(C_2O_4)_{2-1} \cdot 2H_2O$	3.450	2.360	" + $KHC_2O_4$
7.412	0.064	$KH_2(C_2O_4)_{2-1} \cdot 2H_2O$	3.793	3.199	$KHC_2O_4$
2.827	0.238	"	5.457	5.919	"
2.007	0.346	"	9.816	11.96	" + $2K_2C_2O_4 \cdot H_2C$
1.734	0.567	"	12.365	15.71	$2K_2C_2O_4 \cdot H_2C_2O_4 \cdot 2H_2O$
2.675	1.714	"	11.85	15.51	$K_2C_2O_4 \cdot H_2C$

Similar data at 15° for the above system are given by Jungfleisch a (1914a).



## SOLUBILITIES IN THE SYSTEM POTASSIUM OXALATE, OXALIC ACID, WATER AT THE CRYOHYDRIC POINTS.

(Koppel and Cahn, 1908.)

(Temp. of Equilibrium of Solution with Ice.)

t° of Ice Separation.	Gms. per 100 Gms. Sat. Sol.		Solid Phase, Ice +:	-	t° of Ice Separation.	Gms. per 100 Gms. Sat. Sol.		Solid Phase, Ice +:
	C <sub>2</sub> O <sub>3</sub>	K <sub>2</sub> O.				C <sub>2</sub> O <sub>3</sub>	K <sub>2</sub> O.	
-0.95	2.641	...	H <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .2H <sub>2</sub> O	-	4.45	6.902	8.820	(K <sub>2</sub> C <sub>2</sub> O <sub>4</sub> ) <sub>2</sub> .H <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .2H <sub>2</sub> O
-0.00	2.720	0.0466	" + KH <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>2</sub> .2H <sub>2</sub> O	-	5.20	7.616	9.74	"
-0.52	1.672	0.0602	KH <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>2</sub> .2H <sub>2</sub> O	-	5.32	7.696	9.84	"
-0.25	0.643	0.210	"	-	5.97	8.51	11.01	" + K <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .H <sub>2</sub> O
-0.58	1.220	0.823	"	-	6.55	6.742	10.45	K <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .H <sub>2</sub> O
-0.78	1.648	1.234	" + KHC <sub>2</sub> O <sub>4</sub>	-	8.10	4.999	10.86	"
-1.50	2.707	2.950	KHC <sub>2</sub> O <sub>4</sub>	-	10.30	3.358	11.76	"
-2.10	3.687	4.363	"	-	13.60	1.854	13.08	"
-2.78	4.576	5.50	"	-	17.40	1.200	14.55	"
-3.45	5.681	7.05	" + (K <sub>2</sub> C <sub>2</sub> O <sub>4</sub> ) <sub>2</sub> .H <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .2H <sub>2</sub> O	-	23.80	0.606	16.89	"

## SOLUBILITIES IN THE SYSTEM POTASSIUM OXALATE, OXALIC ACID, WATER AT THE BOILING POINTS.

(Koppel and Cahn, 1908.)

t° of B. pt.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t° of B. pt.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	C <sub>2</sub> O <sub>3</sub>	K <sub>2</sub> O.			C <sub>2</sub> O <sub>3</sub>	K <sub>2</sub> O.	
105.5	39.84	5.25	KH <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>2</sub> .2H <sub>2</sub> O	102.8	19.10	18.25	KHC <sub>2</sub> O <sub>4</sub>
104.9	36.95	5.83	"	103.25	21.11	21.71	"
104.3	32.75	5.97	"	107.7	25.19	27.91	" + K <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .H <sub>2</sub> O
103.4	27.64	9.12	"	106.35	22.04	26.45	K <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .H <sub>2</sub> O
102.9	27.46	11.43	" + KHC <sub>2</sub> O <sub>4</sub>	106.25	19.17	25.02	"
102.5	23.36	10.50	KHC <sub>2</sub> O <sub>4</sub>	108.25	12.73	27.69	"
102.4	18.81	12.29	"	111.8	5.35	30.40	"

From the preceding tables the following results for the solubilities of the pure oxalates in water are obtained.

SOLUBILITY OF POTASSIUM OXALATE, K<sub>2</sub>C<sub>2</sub>O<sub>4</sub>.H<sub>2</sub>O IN WATER.

t°.	Gms. per 100 Gms. Sat. Sol.			Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.			Solid Phase.
	C <sub>2</sub> O <sub>3</sub>	+ K <sub>2</sub> O	= K <sub>2</sub> C <sub>2</sub> O <sub>4</sub>			C <sub>2</sub> O <sub>3</sub>	+ K <sub>2</sub> O	= K <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	
-0.78	1.31	1.71	3.02	Ice	30	12.36	16.14	28.50	K <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .H <sub>2</sub> O
-1.49	2.48	3.20	5.68	"	40	13.20	17.22	30.44	"
-2.50	3.99	5.20	9.195	"	50	14.14	18.46	32.60	"
-3.22	5.15	6.705	11.855	"	60	15.06	19.66	34.72	"
-5.88	8.429	11.01	19.43	" + K <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .H <sub>2</sub> O	70	15.94	20.81	36.75	"
0	8.83	11.52	20.35	K <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .H <sub>2</sub> O	80	16.86	22.02	38.875	"
+10	10.48	13.69	24.17	"	90.2	17.73	23.14	40.90	"
20	11.57	15.11	26.675	"	106.2*	19.17	25.02	44.19	"

\* b. pt.

100 gms. sat. aq. sol. contain 20.62 gms. K<sub>2</sub>C<sub>2</sub>O<sub>4</sub> at 0°,  $d = 1.161$ . (Engel, 1888.)  
The results of Hartley, Drugman, Vlieland and Bourdillon (1913) and of Tolani (1916), for the solubility of neutral potassium oxalate in water, agree satisfactorily with the above.

SOLUBILITY OF POTASSIUM BIOXALATE, KHC<sub>2</sub>O<sub>4</sub>, IN WATER.

(Koppel and Cahn, 1908.)

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	C <sub>2</sub> O <sub>3</sub>	K <sub>2</sub> O.	
60	8.75	6.50	KHC <sub>2</sub> O <sub>4</sub>
102.4 b. pt.	18.81	12.29	"

The KHC<sub>2</sub>O<sub>4</sub> is decomposed to the less soluble tetroxalate at temperatures below 50°.



# POTASSIUM\_OXALATES

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## SOLUBILITY OF POTASSIUM TETROXALATE, $\text{KH}_2(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$ , IN ✓ (Koppel and Cahn, 1908.)

t°.	Gms. $\text{KH}_2(\text{C}_2\text{O}_4)_2$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
-0.25 cryohydrate	0.99	$\text{KH}_2(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$
0	1.27	"
30	4.30	"
60	11.95	"
103.5 b. pt.	72.17	"

## SOLUBILITY OF MIXTURES OF POTASSIUM OXALATE AND OTHER SALTS IN WATER. (Colani, 1916.)

Results at 15°.			Results at 50°.		
Gms. per 100	Gms. Sat. Sol.		Gms. per 100	Gms. Sat. Sol.	Sol.
10.03	$\text{K}_2\text{C}_2\text{O}_4 + 19.19 \text{ KCl}$		15.18	$\text{K}_2\text{C}_2\text{O}_4 + 20.26 \text{ KCl}$	$\text{K}_2\text{C}_2\text{O}_4$
23.55	" + 1.82 $\text{K}_2\text{SO}_4$		31.06	" + 1.99 $\text{K}_2\text{SO}_4$	
20.39	" + 11.60 $\text{KNO}_3$ (19°)		19.63	" + 28.29 $\text{KNO}_3$	

100 gms. aqueous solution, simultaneously saturated with potassium oxalates, contain 26.15 gms.  $\text{K}_2\text{C}_2\text{O}_4$  + 2.44 gms.  $\text{Na}_2\text{C}_2\text{O}_4$  at 21° (Foote and Ai)

## POTASSIUM Telluric Acid OXALATE $\text{K}_2[\text{H}_4\text{TeO}_6 \cdot \text{C}_2\text{O}_4]$ .

### SOLUBILITY IN WATER. (Rosenheim and Weinheber, 1910-11.)

t°	0°	20°	30°	40°
Gms. $\text{K}_2[\text{H}_4\text{TeO}_6 \cdot \text{C}_2\text{O}_4]$ per 100 gms. $\text{H}_2\text{O}$	2.67	5.36	6.82	9.6

## POTASSIUM PERMANGANATE $\text{KMnO}_4$ .

### SOLUBILITY IN WATER. (Baxter, Boylston, and Hubbard, 1906; Patterson, 1907.)

t°.	Gms. $\text{KMnO}_4$ per 100:			t°.	Gms. $\text{KMnO}_4$ per 100
	Gms. Solution.	Gms. $\text{H}_2\text{O}$ .	cc. Solution (P).		Gms. Solution.
0	2.75	2.83	2.84	34.8	9.64
9.8	4.13	4.31	...	40	11.16
15	...	...	5.22	45	12.73
19.8	5.96	6.34	...	50	14.45
24.8	7.06	7.59	...	55	16.20
29.8	8.28	9.03	8.69	65	20.02

Sp. Gr. of saturated solution at 15° = 1.035.

Determination by Worden (1907), made with extreme care, gave very close agreement with the above.

### SOLUBILITY OF POTASSIUM PERMANGANATE IN:

Water.				Aqueous Acetone Solution	
(Voerman, 1906.)				(Herz and Knoch, 1906.)	
t°.	Gms. $\text{KMnO}_4$ per 100 Gms.		Solid Phase.	cc. Acetone per 100 cc. Solvent.	$\text{KMnO}_4$ per 100 cc.
	Solution.	Water.			Millimols.
-0.18	0.58	0.58	Ice	0	148.5
-0.27	0.99	1.01	"	10	162.5
-0.48	1.98	2.02	"	20	177.3
-0.58	2.91	3	Ice + $\text{KMnO}_4$	30	208.2
+10	4.01	4.22	$\text{KMnO}_4$	40	257.4
15	4.95	5.20	"	50	289.7
25	7	7.53	"	60	316.8
40	10.40	11.61	"	70	328
50	14.35	16.75	"	80	312.5
				90	227
				100	67



**POTASSIUM PERMAN-  
GANATE**

**SOLUBILITY OF POTASSIUM PERMANGANATE IN AQUEOUS SOLUTIONS OF  
POTASSIUM CARBONATE.**  
(Sackur and Taegener, 1912.)

Mols. $\text{KMnO}_4$ per Liter in:				
0.1 $\frac{1}{2}$ $\text{K}_2\text{CO}_3$ .	1 $\frac{1}{2}$ $\text{K}_2\text{CO}_3$ .	2 $\frac{1}{2}$ $\text{K}_2\text{CO}_3$ .	4 $\frac{1}{2}$ $\text{K}_2\text{CO}_3$ .	6 $\frac{1}{2}$ $\text{K}_2\text{CO}_3$ .
0.1462	0.0629	0.0446	0.027	0.0156
0.4375	0.2589	...	0.093	...
0.7380	0.5007	0.3519	...	...

**SOLUBILITY OF POTASSIUM PERMANGANATE IN AQUEOUS SOLUTIONS OF  
POTASSIUM CHLORIDE.**  
(Sackur and Taegener, 1912.)

	Mols. $\text{KMnO}_4$ per Liter in:			
g.	0.1 $\frac{1}{2}$ $\text{KCl}$ .	0.5 $\frac{1}{2}$ $\text{KCl}$ .	1 $\frac{1}{2}$ $\text{KCl}$ .	2 $\frac{1}{2}$ $\text{KCl}$ .
0	0.1395	0.076	0.0532	0.0379
25	0.4315	0.306	0.220	0.1432
40	0.738	0.584	0.444	0.288

**SOLUBILITY OF POTASSIUM PERMANGANATE IN AQUEOUS SOLUTIONS OF  
POTASSIUM HYDROXIDE.**  
(Sackur and Taegener, 1912.)

	Mols. $\text{KMnO}_4$ per Liter in:					
$\text{H}_2\text{O}$ .	1 $\frac{1}{2}$ $\text{KOH}$ .	2 $\frac{1}{2}$ $\text{KOH}$ .	4 $\frac{1}{2}$ $\text{KOH}$ .	6 $\frac{1}{2}$ $\text{KOH}$ .	8 $\frac{1}{2}$ $\text{KOH}$ .	10 $\frac{1}{2}$ $\text{KOH}$ .
0.176	0.050	0.031	0.027	0.023	0.017	0.012
0.278	0.112	0.068	0.048	0.042	0.028	0.016
0.411	0.179	0.119	0.079	0.074 (19°)	0.032	0.029
0.573	0.316 (32°)	0.213 (32°)	0.149 (32°)	0.114	0.062 (32°)	0.040
0.792	0.439	0.306	0.211	0.161	0.084	0.052
1.154 (53°)	0.638	0.462	0.304	0.219	0.111	...
1.812	1.172	0.869	0.572	0.390	0.188	0.082
...	1.513	1.190	...	0.500	0.231	...
...	...	...	...	0.649	0.297	...

**SOLUBILITY OF POTASSIUM MANGANATE IN AQUEOUS SOLUTIONS OF  
POTASSIUM HYDROXIDE.**  
(Sackur and Taegener, 1912.)

The  $\text{K}_2\text{MnO}_4$  was prepared by boiling  $\text{KMnO}_4$  with very conc.  $\text{KOH}$ , draining and washing with ice cold  $\text{K}_2\text{CO}_3$  solution. The impurities were of no consequence since the determinations were made in alkaline solutions.)

Mols. $\text{K}_2\text{MnO}_4$ per Liter in:				
2 $\frac{1}{2}$ $\text{KOH}$ .	4 $\frac{1}{2}$ $\text{KOH}$ .	6 $\frac{1}{2}$ $\text{KOH}$ .	8 $\frac{1}{2}$ $\text{KOH}$ .	10 $\frac{1}{2}$ $\text{KOH}$ .
0.907	0.554	0.155	0.063	0.0145
1.013	...	...	0.070	0.0152
...	0.681 (17°)	0.224	...	...
1.140	0.733 (25°)	0.261 (23°)	0.078	0.0160
1.252	0.772	0.303	0.096	0.0215
...	0.852	0.362	0.119	0.0305
1.424	0.889	0.388	...	...
...	0.938 (51°)	...	0.142	0.0462
...	1.003	0.460	0.167	0.062 (63°)
...	1.074	0.528	0.196	0.070
...	1.143	0.587	0.222	0.083

cc. anhy. hydrazine dissolve 2 gms.  $\text{KMnO}_4$ , with evolution of gas and formation of a brown precipitate, at room temp. (Welsh and Broderick, 1915.)



# POTASSIUM PERMAN- GANATE

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## SOLUBILITY OF MIXED CRYSTALS OF POTASSIUM PERMANGANATE POTASSIUM PERCHLORATE AT 7°.

(Muthmann and Kuntze, 1894; recalculated by Fock, 1897.)

Milligram Mols. per Liter.		Gms. per Liter.		Mol. per Crystals of Phase.
KMnO <sub>4</sub> .	KClO <sub>4</sub> .	KMnO <sub>4</sub> .	KClO <sub>4</sub> .	
0	63.91	0	8.86	0
29.37	54.48	4.65	7.55	2.8
67.73	42.75	10.71	5.93	9.71
79.04	39.59	12.50	5.49	10.81
99.81	38.63	15.79	5.36	15.96
122.24	34.39	19.34	4.77	23.56
119.21	38.91	18.84	5.39	24.28
128.08	33.77	20.26	4.68	26.40
144.46	33.14	22.86	4.59	34.32
167.81	29.53	26.55	4.09	44.42
183.09	25.19	28.97	3.49	67.33
197.82	20.16	31.30	2.80	77.95
233.75	28.26	36.98	3.92	94.3
264.27	0	41.81	0	100

## SOLUBILITY OF MIXED CRYSTALS OF POTASSIUM PERMANGANATE RUBIDIUM PERMANGANATE AT 7°.

(Muthmann and Kuntze, calc. by Fock.)

Milligram Mols. per Liter.		Gms. per Liter.		Mol. per Crystals of Phase.
KMnO <sub>4</sub> .	RbMnO <sub>4</sub> .	KMnO <sub>4</sub> .	RbMnO <sub>4</sub> .	
27.04	22.69	4.28	4.64	3.50
75	22.22	11.84	4.54	13.75
120.26	31.29	19.03	6.40	34.29
188.30	38.98	29.80	7.97	71.45
198.36	41.29	31.39	8.44	92.50
205.76	42.50	32.56	8.69	99.47
225.12	26	35.61	5.32	99.32
264.27	0	41.81	0	100

# POTASSIUM PICRATE C<sub>6</sub>H<sub>2</sub>(NO<sub>2</sub>)<sub>3</sub>OK.

Data for the solubility of potassium picrate in aqueous solutions  
alcohol, methyl alcohol and of acetone at 25° are given by Fisher (1914)

# POTASSIUM PHOSPHATES

## SOLUBILITY OF POTASSIUM ACID PHOSPHATE, KH<sub>2</sub>PO<sub>4</sub>.H<sub>2</sub>PO<sub>4</sub>, IN (Parravano and Mieli, 1908.)

Determinations by Synthetic (sealed tube) Method.

t°.	Gms. KH <sub>2</sub> PO <sub>4</sub> .H <sub>2</sub> PO <sub>4</sub> per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. KH <sub>2</sub> PO <sub>4</sub> .H <sub>2</sub> PO <sub>4</sub> per 100 Gms. Sat. Sol.		Sol.
-0.6	3.337		Ice	65.2	68.44		KH <sub>2</sub> P
-2.5	12.13		"	78	72.43		"
-6.7	29.43		"	87.5	77.6		"
-9.2	36.98		"	105.5	85.9		"
-13 Eutec.	44		" + KH <sub>2</sub> PO <sub>4</sub>	120 tr. pt.	92.1		"
0 (?)	45.8		KH <sub>2</sub> PO <sub>4</sub>	135	96.1		K
+10.9	50.3		"	139	100		

One liter of sat. aq. solution contains 249.9 gms. KH<sub>2</sub>PO<sub>4</sub> at 7°  
(Muthmann)



**SOLUBILITY OF POTASSIUM ACID PHOSPHATE,  $\text{KH}_2\text{PO}_4 \cdot \text{H}_3\text{PO}_4$ , IN ANHYDROUS PHOSPHORIC ACID.**

(Parravano and Mieli, 1908.)

Measurements by Synthetic (sealed tube) Method.

t°.	Gms. per 100 Gms. Sat. Solution.	
	$\text{KH}_2\text{PO}_4 \cdot \text{H}_3\text{PO}_4$	$\text{KH}_2\text{PO}_4$
38.5	18.17	10.56
84	58.42	33.97
110	77.53	45.08
126.5	92.26	51.90

**SOLUBILITY OF POTASSIUM HYDROXIDE, PHOSPHORIC ACID, WATER AT 25°.**

(D'Ans and Schreiner, 1910a; Parker, 1914.)

Results of these investigators agree satisfactorily when plotted on cross-per. The following figures were read from the curves. Some uncertainties in regard to the solid phase in contact with some of the solutions.

Gms. Sat. Sol.	Solid Phase.	Mols. per 1000 Gms. Sat. Sol.		Solid Phase.
$\text{PO}_4$		K.	$\text{PO}_4$	
0	$\text{KOH} \cdot 2\text{H}_2\text{O}$	7	4	$\text{K}_3\text{PO}_4 + \text{K}_2\text{HPO}_4$
0.24	" + $\text{K}_3\text{PO}_4 \cdot 3\text{H}_2\text{O}$	6	3.6	$\text{K}_2\text{HPO}_4$
0.5	$\text{K}_3\text{PO}_4 \cdot 3\text{H}_2\text{O}$	5	3.15	"
1	"	4	2.65	" or $\text{KH}_2\text{PO}_4$ (?)
1.5	"	3	2.2	" " (?)
2	"	2	1.7	" " (?)
2.5	"	1.5	1.5	" " (?)
2.9	"	1.6	2	$\text{KH}_2\text{PO}_4$
2.9	" + $\text{K}_3\text{PO}_4$	2.1	4	"
3	$\text{K}_3\text{PO}_4$	2.5	6	"
3.4	"	3	8	"
3.6	"	1.65	6	$\text{KH}_2\text{PO}_4 \cdot \text{H}_3\text{PO}_4$ (Parker)
3.75	"	1.35	8	" "

Joint data for  $\text{KPO}_3 + \text{K}_4\text{P}_2\text{O}_7$  are given by Parravano and Calcagni (1910).

**POTASSIUM HYPOPHOSPHATE, etc.**

**SOLUBILITY IN WATER.**

(Salzer — Liebig's Ann. 211, 1, 82.)

Salt.	Formula.	Gms. Salt per 100 Gms. $\text{H}_2\text{O}$ .	
		Cold.	Hot.
Hypophosphate	$\text{K}_4\text{P}_2\text{O}_7 \cdot 8\text{H}_2\text{O}$	400	...
Hydrogen Hypophosphate	$\text{K}_2\text{HP}_2\text{O}_6 \cdot 3\text{H}_2\text{O}$	200	...
Di Hydrogen Hypophosphate	$\text{K}_2\text{H}_2\text{P}_2\text{O}_6 \cdot 3\text{H}_2\text{O}$	33	100
Tri Hydrogen Hypophosphate	$\text{KH}_2\text{P}_2\text{O}_6$	66.6	200
Penta Hydrogen Hypophosphate	$\text{K}_2\text{H}_5(\text{P}_2\text{O}_6)_2 \cdot 2\text{H}_2\text{O}$	40	125
Hydrogen Phosphite	$\text{KH}_2\text{PO}_3$	172 (20°)	...
Hypophosphite	$\text{KH}_2\text{PO}_2$	200 (25°)	333
Hypophosphite	$\text{KH}_2\text{PO}_2^*$	14.3 (25°)	28

\* Solvent alcohol.

**POTASSIUM PHOSPHOMOLYBDATE  $\text{K}_3\text{PO}_4 \cdot 11\text{MoO}_3 \cdot 1\frac{1}{2}\text{H}_2\text{O}$ .**

$\text{H}_2\text{O}$  dissolve 0.0007 gm. at 30°.

Aqueous 10%  $\text{HNO}_3$  dissolve 0.204 gm. at 30°. (Donk, M. G., 1905.)



# POTASSIUM SELENATE

556

## POTASSIUM SELENATE $K_2SeO_4$ .

### SOLUBILITY IN WATER.

t°.	-20°.	-5°.	+5°.	18°.	91°.
Gms. $K_2SeO_4$ per 100 gms. solution	51.5	51.7	52	52.6	54.9
100 gms. $H_2O$ dissolve 115 gms. $K_2SeO_4$ at 12°.					(Etard, 1894.) (Tutton, 1897.)

## POTASSIUM SILICATE $K_2SiO_3$ .

Data for equilibrium in the systems  $K_2SiO_3 + H_2O$ ,  $K_2Si_2O_5 + H_2O$ ,  $K_2SiO_3 + SiO_2 + H_2O$  and  $K_2SiO_3 + SiO_2 + H_2O$ , at temperatures between 20° and 1000°, determined by the "hydrothermal quenching method," are given by Morey (1917).

## POTASSIUM STANNATE $K_2SnO_3 \cdot 3H_2O$ .

100 gms.  $H_2O$  dissolve 106.6 gms. at 10°, and 110.5 gms. at 20°. Sp. Gr. at 10° = 1.618 at 20° = 1.627. (Ordway, 1885.)

## POTASSIUM SULFATE $K_2SO_4$ .

### SOLUBILITY IN WATER.

(Mulder; Andrae, 1884; Trevor, 1891; Tilden and Shenstone, 1884; Berkeley, 1904; see also Etard, 1894.)

t°.	Gms. $K_2SO_4$ per 100 Gms.		t°.	Gms. $K_2SO_4$ per 100 Gms.		t°.	Gms. $K_2SO_4$ per 100 Gms.	
	Water.	Solution.		Water.	Solution.		Water.	Solution.
0	7.35	6.85	40	14.76	12.86	90	22.8	18 — 57
10	9.22	8.44	50	16.50	14.16	100	24.1	19 — 42
20	11.11	10	60	18.17	15.38	120	26.5	20 — 94
25	12.04	10.75	70	19.75	16.49	143	28.8	22 — 36
30	12.97	11.48	80	21.4	17.63	170	32.9	24 — 76

Sp. Gr. of solution saturated at 18° = 1.083.

The determinations of Berkeley (1904), which were made with exceptional care, are as follows:

t°.	Sp. Gr. of Sat. Solution.	Gms. $K_2SO_4$ per 100 Gms. $H_2O$ .	t°.	Sp. Gr. of Sat. Solution.	Gms. $K_2SO_4$ per 100 Gms. $H_2O$ .
0.40	1.0589	7.47		1.1089	18.01
15.70	1.0770	10.37		1.1157	20.64
31.45	1.0921	13.34		1.1194	22.80
42.75	1.1010	15.51	101.1 b. pt.	1.1207	24.21

Individual determination in good agreement with the above, are given by Blanc and Schmandt (1911); Greenish and Smith (1901); Osaka (1903-8); Nishida (1910); Smith and Ball (1917).

### SOLUBILITY OF MIXED CRYSTALS OF POTASSIUM SULFATE AND AMMONIUM SULFATE AT 25°.

(Fock, 1897.)

Grams per Liter.		Milligram Mols. per Liter.		Mol. per cent $K_2SO_4$ in Solution.	Sp. Gr. of Solution.	Mol. per 100 Solid Phase.
$K_2SO_4$ .	$(NH_4)_2SO_4$ .	$K_2SO_4$ .	$(NH_4)_2SO_4$ .			
127.9	0.0	734	0.0	100	1.086	100
135.7	115.7	778.5	874.6	47.1	1.149	91. — 28
84.20	281.1	483	2126	18.5	1.200	80 — 05
59.28	355.0	340	2685	11.13	1.226	68 — 63
40.27	482.7	231	3650	5.98	1.246	27 — 53
0.00	542.3	0.0	4100	0.00	1.245	0 — 00

Results are also given for 14°, 15°, 16°, 30°, 46°, and 47°.



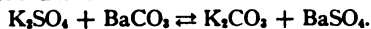
SOLUBILITY OF POTASSIUM SULFATE IN AQUEOUS AMMONIA SOLUTIONS AT 20°.  
(Girard, 1885.)

g. NH <sub>3</sub> per 100 cc. solution	0	6.086	15.37	24.69	31.02
g. K <sub>2</sub> SO <sub>4</sub> per 100 cc. solution	10.80	4.10	0.83	0.14	0.04

1 liter sat. solution in water contains 105.7 gms. K<sub>2</sub>SO<sub>4</sub> at 20°.

1 liter sat. solution in 5.2% NH<sub>3</sub> contains 45.2 gms. K<sub>2</sub>SO<sub>4</sub> at 20°.  
(Konowalow, 1899b.)

SOLUBILITY DATA FOR THE RECIPROCAL SALT PAIR



(Meyerhoffer, 1905.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
K <sub>2</sub> SO <sub>4</sub>	K <sub>2</sub> CO <sub>3</sub>			K <sub>2</sub> SO <sub>4</sub>	K <sub>2</sub> CO <sub>3</sub>	
10.76	0	K <sub>2</sub> SO <sub>4</sub> +BaSO <sub>4</sub>	25	0.602	7.35	BaCO <sub>3</sub> +BaSO <sub>4</sub>
6.76	5.85	"	25	0.173	2.85	"
3.92	12.6	"	80	0.613	2.49	"
2.485	17.81	" + BaCO <sub>3</sub>	80	1.39	4.88	"
1.72	22.1	K <sub>2</sub> SO <sub>4</sub> +BaCO <sub>3</sub>	80	7.1	15.33	" + K <sub>2</sub> SO <sub>4</sub>
0.0886	28.5	"	100	0.797	2.36	BaCO <sub>3</sub> +BaSO <sub>4</sub>
0.023	53.1	" + K <sub>2</sub> CO <sub>3</sub> ·H <sub>2</sub> O	100	1.83	4.51	"
0	53.2	K <sub>2</sub> CO <sub>3</sub> ·H <sub>2</sub> O + BaCO <sub>3</sub>	100	9.42	13.6	" + K <sub>2</sub> SO <sub>4</sub>

SOLUBILITY OF MIXED CRYSTALS OF POTASSIUM COPPER SULFATE AND AMMONIUM COPPER SULFATE IN WATER.

K<sub>2</sub>SO<sub>4</sub>·K<sub>2</sub>SO<sub>4</sub>·6H<sub>2</sub>O and CuSO<sub>4</sub>(NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>·6H<sub>2</sub>O at 13°-14°. (Fock, 1897.)

Mols. per 100 Mols. H <sub>2</sub> O.		Mol. per cent K Salt. in Solution. in Solid.		Mols. per 100 Mols. H <sub>2</sub> O.		Mol. per cent K Salt. in Solution. in Solid.	
Salt.	NH <sub>4</sub> Salt.			K Salt.	NH <sub>4</sub> Salt.		
1.035	0	0		0.2946	0.5096	36.63	58.20
1897 0.8618	5.06	10.34		0.3339	0.3319	50.15	75.34
269 0.6490	16.76	33.05		0.4560	0.1961	69.93	83.86
570 0.5887	30.40	46.22		0.4374	0	100	100

SOLUBILITY OF SOME POTASSIUM DOUBLE SULFATES IN WATER AT 25°.  
(Locke, 1902.)

Double Salt.	Formula.	Gms. Anhydrous Salt per 100 Gms. H <sub>2</sub> O.
Potassium Cobalt Sulfate	K <sub>2</sub> Co(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	12.88
" Copper "	K <sub>2</sub> Cu(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	11.69
" Nickel "	K <sub>2</sub> Ni(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	6.88
" Zinc "	K <sub>2</sub> Zn(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O	13.19

SOLUBILITY OF POTASSIUM NICKEL SULFATE AND ALSO OF POTASSIUM ZINC SULFATE IN WATER, EACH SEPARATELY DETERMINED AT DIFFERENT TEMPERATURES.

t°.	Gms. per 100 Gms. H <sub>2</sub> O.		t°.	Gms. per 100 Gms. H <sub>2</sub> O.	
	K <sub>2</sub> Ni(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O.	K <sub>2</sub> Zn(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O.		K <sub>2</sub> Ni(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O.	K <sub>2</sub> Zn(SO <sub>4</sub> ) <sub>2</sub> ·6H <sub>2</sub> O.
0	6	13	40	23	45
10	9	19	50	28	56
20	14	26	60	35	72
25	16	30	70	43	88
30	18	35			



SOLUBILITY OF THE THREE HYDRATES OF POTASSIUM FERROSUL  
IN WATER AT DIFFERENT TEMPERATURES.  
(Küster and Thiel, 1899.)

t°.	K <sub>2</sub> SO <sub>4</sub> .FeSO <sub>4</sub> .6H <sub>2</sub> O.		K <sub>2</sub> SO <sub>4</sub> .FeSO <sub>4</sub> .4H <sub>2</sub> O.		K <sub>2</sub> SO <sub>4</sub> .FeSO <sub>4</sub> .	
	cc. N/10 KMnO <sub>4</sub> per 2 cc. Solution.	Gms. K <sub>2</sub> SO <sub>4</sub> FeSO <sub>4</sub> per 100 cc. Sol.	cc. N/10 KMnO <sub>4</sub> per 2 cc. Solution.	Gms. K <sub>2</sub> SO <sub>4</sub> FeSO <sub>4</sub> per 100 cc. Sol.	cc. N/10 KMnO <sub>4</sub> per 2 cc. Solution.	
0.5	12.4	18.36	15.5	22.94	15.4	
17.2	17.0	25.16	18.1	26.79	21.6	
40.1	24.8	36.72	21.9	32.41	27.6	
60	29.0	42.93	24.1	35.68	28.8	
80	30.6	45.29	27.3	40.46	28.6	
90	...	...	29.6	43.82	28.9	
95	...	...	29.8	44.11	27.7	

SOLUBILITY OF MIXTURES OF POTASSIUM AND LEAD SULFATES  
POTASSIUM AND STRONTIUM SULFATES IN WATER.  
(Barre, 1909.)

Results for K <sub>2</sub> SO <sub>4</sub> + PbSO <sub>4</sub> .			Results for K <sub>2</sub> SO <sub>4</sub> + SrSO <sub>4</sub> .		
t°.	Gms. K <sub>2</sub> SO <sub>4</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. K <sub>2</sub> SO <sub>4</sub> per 100 Gms. Sat. Sol.	Solid Phase.
7	0.56	PbSO <sub>4</sub> .K <sub>2</sub> SO <sub>4</sub>	17.5	1.27	K <sub>2</sub> SO <sub>4</sub>
17	0.62	"	50	1.88	"
50	1.09	"	75	2.71	"
75	1.37	"	100	3.90	"
100	1.69	"			

SOLUBILITY OF POTASSIUM SULFATE IN AQUEOUS SOLUTIONS OF  
CHLORIDE, BROMIDE, AND IODIDE.  
(Blarez, 1891.)

Interpolated from the original results.

Grams Halogen Salt per 100 cc. Solution.	Grams K <sub>2</sub> SO <sub>4</sub> per 100 cc. in Aq. Solutions of:		
	KCl at 12.5°.	KBr at 14°.	KI at 12.5°.
0	9.9	10.16	9.9
2	8.3	9.1	9.2
4	7.0	8.2	8.4
6	5.7	7.4	7.7
8	4.6	6.6	7.2
10	3.5	6.0	6.6
12	...	5.5	6.0

SOLUBILITY OF POTASSIUM SULFATE IN AQUEOUS SOLUTION  
HYDROXIDE AT 25°.  
(D'Ans and Schreiner, 1910.)

Mols. per 1000 Gms. Sat. Solution.		Gms. per 100 Gms. Sat. Solution.		Mols. per 1000 Gms. Sat. Solution.	
(KOH) <sub>2</sub> .	K <sub>2</sub> SO <sub>4</sub> .	KOH.	K <sub>2</sub> SO <sub>4</sub> .	(KOH) <sub>2</sub> .	K <sub>2</sub> SO <sub>4</sub> .
0	0.617	0	10.75	2.86	0.035
0.258	0.433	2.892	7.544	3.42	0.009
0.433	0.280	4.854	4.878	4.809	0
1.13	0.137	12.67	2.386		



SOLUBILITY OF MIXED CRYSTALS OF POTASSIUM SULFATE AND POTASSIUM  
CHROMATE AT 25°  
(Fock, 1897.)

Mols. per Liter. $K_2CrO_4$ .	Grams per Liter.		Mol. per cent $K_2SO_4$ in Solution.	Sp. Gr. of Solution.	Mol. per cent $K_2SO_4$ in Solid Phase.
	$K_2SO_4$ .	$K_2CrO_4$ .			
0.0	107.7	0.00	100.0	1.083	100.0
103	106.0	20.02	85.51	1.092	99.65
691.8	59.46	134.5	33.01	1.141	97.30
1496.0	30.47	290.5	10.50	1.231	91.97
2523	19.30	490.5	4.21	1.356	28.43
2687	17.54	522.3	3.60	1.377	2.41
2847	0.0	553.5	0.00	1.398	0.00
0.0	127.9	0.0	100.0	1.0863	100.0
103.4	107.6	20.1	85.65	1.0934	99.78
452.7	80.72	88.0	55.55	1.1235	98.49
948.2	48.64	184.4	22.72	1.1700	96.07
1469.	26.68	285.6	9.41	1.2255	85.77
2681	51.61	521.2	21.09	1.3688	25.73
2715	0.00	527.8	0.00	1.3781	0.00

SOLUBILITY OF POTASSIUM SODIUM SULFATES IN WATER.

Double Salt.	t°.	Gms. per 100 Gms. $H_2O$ .	Authority.
$K_2SO_4.Na_2SO_4$	103.5	40.8	(Penny, 1855.)
$K_2SO_4.Na_2SO_4$	4.4	9.2	(Gladstone, 1854.)
"	12.7	10.1	
"	100	25	

SOLUBILITY OF POTASSIUM SULFATE IN AQUEOUS SOLUTIONS OF SODIUM  
SULFATE.

Results at 25°.  
(Landolt and Ball, 1917.)

Results at 34° and at 60°.  
(Nacken, 1910.)

per 100 Gms. $H_2O$ .	Gms. per 100 Gms. Sat. Sol. at 34°.		Gms. per 100 Gms. Sat. Sol. at 60°.		Solid Phase at 34° and at 60°.
	$Na_2SO_4$ .	$K_2SO_4$ .	$Na_2SO_4$ .	$K_2SO_4$ .	
12.05	0	11.9	0	15.3	$K_2SO_4$
12.33	7.1	10.7	6.6	13.9	" + Glaserite
12.65	31.4	4.3	27.1	8.2	$Na_2SO_4$ + Mix crystals
12.89	33.1	0	31.3	0	$Na_2SO_4$
13.12					

Additional data for the above system at 15°, 25°, 40°, 50°, 60°, 70° and 80° are given by Okada (1914). The results show that potassium and sodium sulfates form a double salt of the composition  $K_2Na(SO_4)_2$ . This double salt dissolves in water as a solid solution but not potassium sulfate.



SOLUBILITY OF POTASSIUM SULFATE IN AQUEOUS SOLUTIONS OF  
ACID AT 18°.  
(Stortenbecker, 1902.)

Mols. per 100 Mols. $K_2SO_4 + H_2SO_4 + H_2O$ .		Solid Phase.	Mols. per 100 Mols. $K_2SO_4 + H_2SO_4 + H_2O$ .		S
$K_2SO_4$	$H_2SO_4$		$K_2SO_4$	$H_2SO_4$	
1.10	0	$K_2SO_4$	2.80	5.79	$K_4$
1.59	0.95	"	2.61	5.61	$K_4$
2.49	2.70	"	2.25	6.19	.
2.75	3.17	$K_2SO_4.KHSO_4$	1.08	7.94	
2.75	3.74	"	0.77	9.2	
2.83	5.08	"	0.44	22.7	

SOLUBILITY OF POTASSIUM SULFATE IN AQUEOUS SOLUTIONS OF  
ACID AT 0°.  
(D'Ans, 1909a.)

Mols. per 1000 Gms. Sat. Sol.		Solid Phase.	Mols. per 1000 Gms. Sat. Sol.		Sol
$K_2SO_4$	$H_2SO_4$		$K_2SO_4$	$H_2SO_4$	
0.53	0.37	$K_2SO_4$	0.61	2.12	
0.64	0.75	"	0.54	2.29	$K_b$
0.74	1.08	" + $K_2H(SO_4)_2$	0.53	2.30	"
0.73	1.13	$K_2H(SO_4)_2$	0.43	2.48	
0.71	1.44	"	0.28	3.04	
0.69	1.66	"	0.12	4.43	
0.69	1.88	" + $K_a$	0.09	5.27	

$K_a$  and  $K_b$  are acid sulfates between  $K_2H(SO_4)_2$  and  $KHSO_4$ . The  
tions were not determined.

SOLUBILITY OF POTASSIUM SULFATE IN AQUEOUS SOLUTIONS OF  
ACID AT 25°.  
(D'Ans, 1909a, 1913; see also Herz, 1911-12.)

Mols. per 1000 Gms. Sat. Sol.		Solid Phase.	Mols. per 1000 Gms. Sat. Sol.		Sol
$K_2SO_4$	$H_2SO_4$		$K_2SO_4$	$H_2SO_4 + SO_3$	
1.27	1.31	$K_2SO_4 + K_2H(SO_4)_2$	0.250	8.10	$KH_4(S$
1.33	1.99	$K_2H(SO_4)_2 + K_y$	0.352	8.15	"
1.24	2.03	$K_y$	0.364	8.16	" +
1.13	2.17	"	0.341	8.29	$KH_4(S$
1.04	2.35	" + $KHSO_4$	0.322	8.33	"
1.032	2.345	$KHSO_4$	0.325	8.45	"
0.67	2.83	"	0.346	6.62	"
0.22	4.13	"	0.384	8.57	"
0.15	5.36	"	0.412	8.71	"
			0.583	8.82	"
$K_2SO_4$	$H_2SO_4 + SO_3$		0.880	8.65	" +
0.171	6.42	$KHSO_4$	0.899	8.63	$KHS_2$
0.190	6.60	"	0.882	8.70	"
0.266	6.91	" + $KH_4(SO_4)_2.H_2O$	0.561	8.96	"
0.182	7.26		0.365	9.80	"
0.157	7.62		0.43	9.78	"
0.167	7.88		0.665	9.80	"
0.201	8		0.937	9.66	"

$K_y$  = an acid sulfate between  $K_2H(SO_4)_2$  and  $KHSO_4$  of which the  
position was not determined.



## SOLUBILITY OF POTASSIUM SULFATE IN AQUEOUS ALCOHOL.

(Gerardin, 1865; Schiff, 1861.)

In Aq. Alcohol of 0.939  
Sp. Gr. = 40 Wt. %.

°.	Gms. $K_2SO_4$ per 100 Gms. Alcohol.
40	0.16
80	0.21
60	0.92

In Alcohol of Different  
Strengths at 15°.

Weight per cent Alcohol.	Gms. $K_2SO_4$ per 100 Gms. Sat. Sol.
10	3.90
20	1.46
30	0.56
40	0.21

## SOLUBILITY OF POTASSIUM SULFATE IN AQUEOUS ALCOHOL AT 25°.

(Fox and Gauge, 1910.)

Gms. per 100 Gms. Sat. Solution.			Gms. per 100 Gms. Sat. Solution.		
$K_2SO_4$ .	$C_2H_5OH$ .	$H_2O$ .	$K_2SO_4$ .	$C_2H_5OH$ .	$H_2O$ .
9 - 17	1.35	89.48	2.66	15.26	82.08
6 - 90	4.80	88.30	1.83	20.50	77.67
4 - 96	7.80	87.24	0.97	26.91	72.12
4 - 32	9.70	85.98	0.41	35.97	63.62
3 - 57	12.34	84.09	0.22	43.90	55.88
2 - 71	14.51	82.78	0.016	69.26	30.72

## SOLUBILITY OF POTASSIUM SULFATE AT 25° (Fox and Gauge, 1910.) IN:

Aqueous Chloral Hydrate Solutions.

Gms. per 100 Gms. Sat. Solution.		
$K_2SO_4$ .	$CCl_3CH(OH)_2$ .	$H_2O$ .
9 - 13	6.44	84.43
3 - 41	9.09	82.50
7 - 79	12.38	79.83
7 - 31	13.20	79.49
5 - 88	22.07	72.05
4 - 54	33.15	62.31
3 - 36	44.40	52.24
2 - 92	47.30	49.78
	62.82	35.18
1 - 75	70.28	27.97
1 - 40	80.36	18.24
1 - 08	85.26	13.66

Aqueous Glycerol Solutions.

Gms. per 100 Gms. Sat. Solution.		
$K_2SO_4$ .	$(CH_2OH)_2CHOH$ .	$H_2O$ .
8.87	8.96	82.17
7.69	13.36	78.95
6.47	20.34	73.19
5.83	24.15	70.02
4.44	33.73	61.83
3.65	40.40	55.95
3.38	43.52	53.10
2.69	50.18	47.13
2.07	57.22	40.71
1.53	67.94	30.53
0.98	78.18	20.84
0.73	98.28	0.99

## SOLUBILITY OF POTASSIUM SULFATE AT 25° (Fox and Gauge, 1910.) IN:

Aqueous Acetone Solutions.

Gms. per 100 Gms. Sat. Solution.		
$K_2SO_4$ .	$(CH_3)_2CO$ .	$H_2O$ .
7 - 20	4.92	87.88
5 - 02	10.06	84.92
2 - 96	16.23	80.81
1 - 50	24.31	74.19
0 - 47	37.19	62.34
0 - 20	46.29	53.51
0 - 03	62.40	37.57

Aqueous Pyridine Solutions.

Gms. per 100 Gms. Sat. Solution.		
$K_2SO_4$ .	$CH<(CH_2CH_2)_5N$ .	$H_2O$ .
7.95	4.23	87.82
4.77	13.90	81.33
2.75	24.51	72.74
1.47	34.19	64.34
0.45	46.29	53.26
0.12	55.93	43.95
0.006	75.90	24.09



SOLUBILITY OF POTASSIUM SULFATE AT 25° (Fox and Gauge, 1910) IN:  
Aqueous Ethylene Glycol Solutions. Aqueous Mannitol Solutions.

Gms. per 100 Gms. Sat. Solution.			Gms. per 100 Gms. Sat. Solution.		
K <sub>2</sub> SO <sub>4</sub> .	(CH <sub>2</sub> OH) <sub>2</sub> .	H <sub>2</sub> O.	K <sub>2</sub> SO <sub>4</sub> .	(CHOH) <sub>6</sub> (CH <sub>2</sub> OH) <sub>4</sub> .	H <sub>2</sub> O.
9.67	3.16	87.17	10.32	3.20	86.48
7.69	9.79	82.53	9.61	8.35	82.04
5.74	18.47	75.79	9.19	11.26	79.55
3.57	32.11	64.32	8.66	14.30	77.04
1.83	49.03	49.14	8.35	17.22	74.43

SOLUBILITY OF POTASSIUM SULFATE AT 25° IN:

Aq. Sucrose Solutions.  
(Fox and Gauge, 1910.)

Aq. Potassium Acetate Solutions.  
(Fox, 1909.)

Gms. per 100 Gms. Sat. Solution.			Gms. per 100 Gms. Sat. Solution.		
K <sub>2</sub> SO <sub>4</sub> .	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub> .	H <sub>2</sub> O.	K <sub>2</sub> SO <sub>4</sub> .	CH <sub>3</sub> COOK.	H <sub>2</sub> O.
9.65	9.56	80.79	6.65	6.11	87.24
8.65	18.55	72.80	5.09	8.68	86.23
7.42	28.16	64.42	3.99	11.29	84.72
6.35	37.24	56.41	2.35	15.59	82.06
5.21	47.55	47.24	1.23	20.12	78.65
4.24	57	38.76	0.39	29.95	69.66

100 gms. glycerol of  $d = 1.255$  dissolve 1.316 gms. K<sub>2</sub>SO<sub>4</sub> at ord. temp. (Vogel, 1893.)

SOLUBILITY OF POTASSIUM SULFATE IN AQUEOUS ACETIC ACID AND AQUEOUS PHENOL SOLUTIONS AT 25°.

(Rothmund and Wilsmore, 1902.)

In Aq. Acetic Acid.

In Aq. Phenol.

Mols. per Liter.		Grams per Liter.		Mols. per Liter.		Grams per Liter.	
CH <sub>3</sub> COOH.	K <sub>2</sub> SO <sub>4</sub> .	CH <sub>3</sub> COOH.	K <sub>2</sub> SO <sub>4</sub> .	C <sub>6</sub> H <sub>5</sub> OH.	K <sub>2</sub> SO <sub>4</sub> .	C <sub>6</sub> H <sub>5</sub> OH.	K <sub>2</sub> SO <sub>4</sub> .
0.0	0.6714	0.0	117.0	0.0	0.6714	0.0	117.0
0.07	0.6619	4.2	115.4	0.032	0.6598	3.01	115.0
0.137	0.6559	8.22	114.4	0.064	0.6502	6.02	113.3
0.328	0.6350	19.68	110.8	0.127	0.6310	11.94	110.0
0.578	0.6097	34.68	106.3	0.236	0.6042	22.19	105.3
1.151	0.5556	69.06	96.87	0.308	0.5834	28.97	101.7
2.183	0.4743	128.58	82.70	0.409	0.5572	38.46	97.1
				0.464	0.5480	43.63	95.1
				0.498 (sat.)	0.5377	46.82	93.8

100 gms. water dissolve 10.4 gms. K<sub>2</sub>SO<sub>4</sub> + 219 gms. sugar at 31.25°, or 10.4 gms. sat. solution contain 3.18 gms. K<sub>2</sub>SO<sub>4</sub> + 66.74 gms. sugar. (Köhler, 1897.)

100 gms. 95% formic acid dissolve 36.5 gms. K<sub>2</sub>SO<sub>4</sub> at 21°. (Aschan, 1913.)

100 gms. 95% formic acid dissolve 14.6 gms. KHSO<sub>4</sub> at 19.3°.

100 cc. anhydrous hydrazine dissolve 5 gms. K<sub>2</sub>SO<sub>4</sub> at room temp.

100 gms. hydroxylamine dissolve 3.5 gms. K<sub>2</sub>SO<sub>4</sub> at 17-18°. (Welsh and Broderson, 1915.) (de Bruyn, 1892.)

FREEZING-POINT DATA (Solubility, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES:

K <sub>2</sub> SO <sub>4</sub> + K <sub>2</sub> WO <sub>4</sub> .	(Amadori, 1913.)
" + Ag <sub>2</sub> SO <sub>4</sub> .	(Nacken, 1907b.)
" + NaCl.	(Sackur, 1911-12.)
" + Na <sub>2</sub> SO <sub>4</sub> .	(Jaenecke, 1908; Nacken, 1907 (b) (c); Sackur, 1911-12.)
" + SrSO <sub>4</sub> .	(Grahmann, 1913; Calcagni, 1912, 1912a.)



**SOLUBILITY OF POTASSIUM BISULFATE  $\text{KHSO}_4$** **SOLUBILITY IN WATER.**

(Kremers, 1854.)

$t^\circ$ .	$0^\circ$ .	$20^\circ$ .	$40^\circ$ .	$100^\circ$ .
$\text{HSO}_4$ per 100 gms. $\text{H}_2\text{O}$	36.3	51.4	67.3	121.6

so p. 560.

**SOLUBILITY OF POTASSIUM PERSULFATE  $\text{K}_2\text{S}_2\text{O}_8$** **SOLUBILITY IN WATER.**

(Tarugi, 1904.)

Gms. $\text{K}_2\text{S}_2\text{O}_8$ per 100 cc. Sat. Sol.	$t^\circ$ .	Gms. $\text{K}_2\text{S}_2\text{O}_8$ per 100 cc. Sat. Sol.	$t^\circ$ .	Gms. $\text{K}_2\text{S}_2\text{O}_8$ per 100 cc. Sat. Sol.
1.620	15	3.140(3.7)	30	7.190(7.7)
2.156	20	4.490	35	8.540
2.600	25	5.840	40	9.890

Results in parentheses are the averages of a large number of determinations (1906). This investigator employed constant agitation for various times. Tarugi approached equilibrium from above as well as below but he solutions only at intervals. The determination of the dissolved persulfates was made by boiling a measured volume of the clear saturated solution for and titrating the  $\text{H}_2\text{SO}_4$  liberated, according to the equation  $\text{K}_2\text{S}_2\text{O}_8 + \text{H}_2\text{O} \rightarrow 2\text{H}_2\text{SO}_4 + \text{O}$ . Tarugi also reports that the presence of a number of other salts in solution, does not appreciably alter the solubility of potassium persulfate in water.

100 gms.  $\text{H}_2\text{O}$  dissolve 1.77 gms.  $\text{K}_2\text{S}_2\text{O}_8$  at  $0^\circ$ .

(Marshall, 1891.)

**SOLUBILITY OF POTASSIUM PERSULFATE IN SATURATED AQUEOUS SALT SOLUTIONS AT  $12^\circ$ .**

(Pajetta, 1906.)

Amounts of the salt and of  $\text{K}_2\text{S}_2\text{O}_8$  was, in each case, added to water and the mixture stirred at constant temperature for 10 to 20 hours.)

Salt.	Gms. $\text{K}_2\text{S}_2\text{O}_8$ per 100 Gms. Sat. Sol.	Salt.	Gms. $\text{K}_2\text{S}_2\text{O}_8$ per 100 Gms. Sat. Sol.
Water alone	3.196	$\text{K}_2\text{SO}_4$	0.798
$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$	6.238	$\text{KHSO}_4$	0.336
$\text{H}_2\text{SO}_4$	8.842	$\text{KNO}_3$	0.904
$\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$	4.766	$\text{K}_2\text{CO}_3$	0.0146
$\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$	3.825	$\text{KHCO}_3$	0.317
$\text{NaNO}_3$	19.302	$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	2.990
$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$	5.682	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	3.384
$\text{HCO}_3\text{Na}$	5.042		

Qualitative determinations made with salt solutions of lower concentrations and dilution, gave the following results at  $12.5^\circ$ .

k.	Gms. Salt per 100 Gms. $\text{H}_2\text{O}$ .	Gms. $\text{K}_2\text{S}_2\text{O}_8$ per 100 Gms. Sat. Sol.	Salt.	Gms. Salt per 100 Gms. $\text{H}_2\text{O}$ .	Gms. $\text{K}_2\text{S}_2\text{O}_8$ per 100 Gms. Sat. Sol.
	2.304	4.297	$\text{NaHSO}_4$	5.218	4.556
	3.652	4.230	$\text{NaNO}_3$	3.696	4.613
$10\text{H}_2\text{O}$	7	4.554	$\text{Na}_2\text{HPO}_4$	3.086	4.446

**SOLUBILITY OF POTASSIUM ETHYL SULFATE  $\text{K}(\text{C}_2\text{H}_5)\text{SO}_4$** **SOLUBILITY IN WATER.**

(Illingworth and Howard, 1884.)

$t^\circ$ .	Gms. $\text{K}(\text{C}_2\text{H}_5)\text{SO}_4$ per 100 Gms. Sat. Sol.
-14.2	45.01
0	53.71
+15	62.35



SOLUBILITY OF POTASSIUM ETHYL SULFATE, POTASSIUM METHYL SULFATE AND OF POTASSIUM AMYL SULFATE IN WATER, DETERMINED BY THE FREEZING-POINT METHOD.

(Illingworth and Howard, 1884.)

Results for $K(C_2H_5)SO_4 + H_2O$ .			Results for $K(CH_3)SO_4 + H_2O$ .			Results for $K(C_4H_9)SO_4 + H_2O$ .		
t° of Solidification.	Gms. $K(C_2H_5)SO_4$ per 100 Gms. Sol.	Solid Phase.	t° of Solidification.	Gms. $K(CH_3)SO_4$ per 100 Gms. Sol.	Solid Phase.	t° of Solidification.	Gms. $K(C_4H_9)SO_4$ per 100 Gms. Sol.	Solid Phase.
- 2.2	10	Ice	- 2.3	10	Ice	- 1.9	10	Ice
- 4.9	20	"	- 3.6	15	"	- 4.3	20	"
- 8.2	30	"	- 5	20	"	- 5.4	24	"
- 12.1	40	"	- 8	30	"			"
- 14.2	45.01	" + $K(C_2H_5)SO_4$	- 11.8	39.84	" + $K(CH_3)SO_4$	- 4.8	25	" + $K(C_4H_9)SO_4$
- 6	50	$K(C_2H_5)SO_4$	- 11.5	40	$K(CH_3)SO_4$	0	33.44	"
0	53.71	"	0	47.1	"	+ 17.3	59.46	"
+ 15	62.35	"	+ 12.3	54.8	"			

**POTASSIUM Sodium SULFITE**  $KNa_2H(SO_3)_{2.4}H_2O$ .  
100 gms.  $H_2O$  dissolve 69 gms. of the salt at 15°.

(Schwider, 1889.)

POTASSIUM SULFONATES

SOLUBILITY IN WATER.

Salt.	t°.	Gms. Anhydrous Salt per 100 Gms. $H_2O$ .	Authority.
Potassium Naphthalene Monosulfonate. $\frac{1}{2}H_2O$	25	8.48*	(Witt, 1915.)
" 2 Phenanthrene Monosulfonate. $\frac{1}{2}H_2O$	20	0.273	(Sandquist, 1912.)
" 3 " " " $\frac{1}{2}H_2O$	20	0.342	"
" 10 " " " $\frac{1}{2}H_2O$	20	0.84	"
" 0 Guaiacol Sulfonate (Thiocol)	15-20	16.6	(Squire & Caine, 1905.)

\* d = 1.029

100cc. 90 vol. % alcohol dissolve 0.25 gm. thiocol at 15°-20°. (Squire and Caine, 1905.)

**POTASSIUM SULFIDE**  $K_2S$ .

Fusion-point data for  $K_2S + S$  are given by Thomas and Rule (1917).

**POTASSIUM Antimony SULFIDE**, see Potassium Sulfoantimonate, p. 565.

**POTASSIUM TARTRATE**  $(K_2C_4H_4O_6)_2 \cdot H_2O$ .

100 gms.  $H_2O$  dissolve 138 gms.  $K_2C_4H_4O_6$  at 16.6°, Sp. Gr. of sat. sol. = 1.80 (Greenish and Smith, 1911.)

**POTASSIUM (Bi) TARTRATE** (Mono)  $KHC_4H_4O_6$ , Cream of Tartar.

SOLUBILITY OF MONO POTASSIUM TARTRATE IN WATER.

(Alluard, 1865; Roelofsens, 1894; Blarez, 1891; at 20°, Magnanini, 1901; at 25°, Noyes and Clement, 1912.)

t°.	Gms. $KHC_4H_4O_6$ per 100 Gms. Solution.			t°.	Gms. $KHC_4H_4O_6$ per 100 Gms. Solution.		
0	0.30 (R.)	0.32 (A.)	0.35 (B.)	40	0.96	1.3	1.29
10	0.37	0.40	0.42	50	1.25	1.8	1.80
20	0.49	0.53 (M.)	0.60	60	...	2.4	...
25	0.58	0.654 (N. and C.)	0.74	80	...	4.4	...
30	0.69	0.9 (A.)	0.89	100	...	6.5	...

SOLUBILITY OF MONO POTASSIUM TARTRATE IN AQUEOUS ALCOHOL AT 25°.

(Seidell, 1910.)

Wt. % $C_2H_5OH$ in Solvent	d <sub>25</sub> of Sat. Sol.	Gms. $KHC_4H_4O_6$ per 100 Gms. Sat. Sol.	Wt. % $C_2H_5OH$ in Solvent.	d <sub>25</sub> of Sat. Sol.	Gms. $KHC_4H_4O_6$ per 100 Gms. Sat. Sol.
0	1.002	0.649	50	0.912	0.064
10	0.985	0.358	60	0.890	0.043
20	0.970	0.210	80	0.842	0.023
30	0.953	0.131	92.3	0.807	0.014
40	0.933	0.087	100	0.789	0.010



TABLE OF MONO POTASSIUM TARTRATE IN AQUEOUS ALCOHOL AT 18°.  
(Paul, 1917.)

$\frac{1}{2}$ H <sub>2</sub> O per 100 cc. solvent	0	5	8	10
CH <sub>2</sub> H <sub>4</sub> O <sub>6</sub> per liter sat. sol.	4.903	3.58	2.94	2.57

Similar determinations at other temperatures are given by Roelofsens and Wenger (1892).

SOLUBILITY OF MONO POTASSIUM TARTRATE (KHC<sub>4</sub>H<sub>4</sub>O<sub>6</sub>) IN NORMAL SOLUTIONS OF ACIDS AT 20°.  
(Ostwald; Huecke, 1884.)

Potassium bitartrate was added in excess to normal solutions of the acids, and, after each 1 cc. portions of each solution were withdrawn and titrated with a very 0.1 N Ba(OH)<sub>2</sub> solution; 1 cc. normal acid requiring 10.63 cc. of 0.1 N Ba(OH)<sub>2</sub> solution.

Gms. Acid per 100 cc. Solvent.	cc. N/10 Ba(OH) <sub>2</sub> per 1 cc. Solution.	Gms. KHC <sub>4</sub> H <sub>4</sub> O <sub>6</sub> per 100 cc. Solution.	Acid.	Gms. Acid per 100 cc. Solvent.	cc. N/10 Ba(OH) <sub>2</sub> per 1 cc. Solution.	Gms. KHC <sub>4</sub> H <sub>4</sub> O <sub>6</sub> per 100 cc. Solution.
6.31	5.77*	10.21	C <sub>2</sub> H <sub>5</sub> SO <sub>3</sub> H	11.0	5.01*	8.87
3.65	5.32	9.42	HO.(CH <sub>2</sub> ) <sub>4</sub> SO <sub>3</sub> H	12.61	5.33	9.43
8.10	5.38	9.75	C <sub>6</sub> H <sub>5</sub> SO <sub>3</sub> H	15.81	5.25	9.29
12.80	5.43	9.61	HCOOH	4.60	0.45	0.80
4.90	3.97	7.03	CH <sub>3</sub> COOH	6.00	0.27	0.48
11.21	5.58	12.44	CH <sub>3</sub> ClCOOH	9.45	1.01	1.79
12.61	5.41	9.58	C <sub>2</sub> H <sub>5</sub> COOH	7.40	0.24	0.42
14.01	5.21	9.22	C <sub>6</sub> H <sub>5</sub> COOH	8.81	0.23	0.41

\* The figures in this column show the amount of the Ba(OH)<sub>2</sub> solution in excess of that which would be required by the normal acid solution alone in each case, viz., 10.63 cc. They, therefore, correspond to the amount of KHC<sub>4</sub>H<sub>4</sub>O<sub>6</sub> dissolved in 1 cc. of each saturated solution, and when multiplied by 10.63 give the grams of KHC<sub>4</sub>H<sub>4</sub>O<sub>6</sub> per 100 cc. solution.

SOLUBILITY OF MONO POTASSIUM TARTRATE (KHC<sub>4</sub>H<sub>4</sub>O<sub>6</sub>) IN AQUEOUS SOLUTIONS OF ELECTROLYTES AT 25°.  
(Noyes and Clement, 1894; Magnanini, 1901.)

n. Equiv. per Liter.		Gms. per Liter.		Electro- lyte.	Gm. Equiv. per Liter.		Gms. per Liter.	
ctro- te.	KHC <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	Electro- lyte.	KHC <sub>4</sub> H <sub>4</sub> O <sub>6</sub>		Electro- lyte.	KHC <sub>4</sub> H <sub>4</sub> O <sub>6</sub>	Electro- lyte.	KHC <sub>4</sub> H <sub>4</sub> O <sub>6</sub>
25	0.0254	1.86	4.788	CH <sub>3</sub> COOK	0.05	0.0410	4.91	7.718
25	0.0196	3.73	3.680	"	0.10	0.0504	9.82	9.486
10	0.0133	7.46	2.509	"	0.20	0.0634	19.63	11.930
20	0.0087	14.92	1.636	KHSO <sub>4</sub> (20°)	0.01	0.0375	1.36	7.06
25	0.0256	3.06	4.821	"	0.02	0.0500	2.72	9.41
25	0.0197	6.13	3.716	"	0.10	0.1597	13.62	30.06
10	0.0138	12.26	2.601	KHC <sub>2</sub> O <sub>4</sub> * (20°)	0.01	0.0369	1.28	6.94
20	0.0097	24.52	1.728	"	0.02	0.0424	2.56	7.98
25	0.0192	5.95	3.699	"	0.10	0.1132	12.82	21.30
10	0.0134	11.91	2.517	HCl	0.013	0.0367	0.45	6.90
20	0.0087	23.82	1.629	"	0.025	0.0428	0.91	8.06
25	0.0196	8.30	3.687	"	0.050	0.0580	1.82	11.09
10	0.0132	16.61	2.492	NaCl	0.05	0.0376	2.92	7.08
20	0.0086	33.22	1.619	"	0.10	0.0397	5.85	7.48
25	0.0195	5.06	3.676	"	0.20	0.0428	11.70	8.05
10	0.0136	10.12	2.551	NaClO <sub>3</sub>	0.05	0.0382	5.32	7.18
20	0.0090	20.24	1.696	"	0.10	0.0405	10.65	7.63
25	0.0208	4.36	3.921	"	0.20	0.0446	21.30	8.40
10	0.0147	8.72	2.769					
20	0.0100	17.44	1.888					

\* = acid potassium oxalate.



# POTASSIUM TARTRATE 566

**POTASSIUM Sodium TARTRATE.**  $\text{KNa} \cdot \text{C}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ . (Rochelle ~~Wile~~ or Seig-  
nette Salt.)

100 gms. sat. aq. solution contain 36.66 gms.  $\text{KNaC}_4\text{H}_4\text{O}_6$  at  $9.7^\circ$  and 47.97 gms  
at  $29.5^\circ$ . (van't Hoff and Goldschmidt, 1895;  
100 gms.  $\text{H}_2\text{O}$  dissolve 53.53 gms.  $\text{KNaC}_4\text{H}_4\text{O}_6$  at  $15^\circ$ , Sp. Gr. of sol. = 1.2713  
(Greenish & Smith, 1901.)

## SOLUBILITY OF MIXTURES OF POTASSIUM TARTRATE AND OF SODIUM TARTRATE IN WATER AT SEVERAL TEMPERATURES. (van Leeuwen, 1897.)

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	$\text{K}_2\text{C}_4\text{H}_4\text{O}_6$	$\text{Na}_2\text{C}_4\text{H}_4\text{O}_6$			$\text{K}_2\text{C}_4\text{H}_4\text{O}_6$	$\text{Na}_2\text{C}_4\text{H}_4\text{O}_6$	
18	19.2	16.5	$\text{KNaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$	26.6	56	4.2	$\text{KNaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O} + \text{K}_2\text{T}$
38	26.6	22.8	"	48.3	51.6	13.2	"
20.9	11.8	28	" + $\text{Na}_2\text{T}$	59.7	44.5	25.3	$\text{K}_2\text{T} + \text{Na}_2\text{T}$
38	25.8	24.7	"	80	39.7	34.7	"
50	36.7	23.9	"				



## SOLUBILITY OF SEVERAL POTASSIUM SALTS OF TARTARIC ACIDS IN WATER AT $20^\circ$ . (Schlossberg, 1900.)

Salt.	Formula.	Gms. Sa. Gms.	lt per 100 Sat. Sol.
Potassium Sodium Salt of Racemic Acid	$\text{KNa}(\text{C}_4\text{H}_4\text{O}_6) \cdot 3\text{H}_2\text{O}$	62	.84
Potassium Sodium Salt of <i>d</i> Tartaric Acid	$\text{KNa}(\text{C}_4\text{H}_4\text{O}_6) \cdot 4\text{H}_2\text{O}$	63	.50
Potassium Neutral Inactive Pyrotartrate	$\text{K}_2\text{C}_2\text{H}_2\text{O}_6 \cdot \text{H}_2\text{O}$	56	.33
Potassium Neutral Dextropyrotartrate	$\text{K}_2\text{C}_2\text{H}_2\text{O}_6$	57	.62

## SOLUBILITY OF POTASSIUM SODIUM TARTRATE IN AQ. ALCOHOL SOLUTIONS (Seidell, 1910.)

Wt. % $\text{C}_2\text{H}_5\text{OH}$ in Solvent.	$d_{20}$ of Sat. Sol.	Gms. $\text{KNaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ per 100 Gms. Solvent.	Wt. % $\text{C}_2\text{H}_5\text{OH}$ in Solvent.	$d_{20}$ of Sat. Sol.	Gms. $\text{KNaC}_4\text{H}_4\text{O}_6$ per 100 Gms. S.
0	1.310	53.33	50	0.908	2.40
10	1.216	41.60	60	0.878	0.90
20	1.124	26.20	70	0.857	0.30
30	1.034	13.80	80	0.840	0.06
40	0.961	6	100	0.789	trace

**POTASSIUM Dihydroxy TARTRATES**  $\text{K}_2\text{C}_4\text{H}_4\text{O}_6 \cdot \text{H}_2\text{O}$  and  $\text{KHC}_4\text{H}_4\text{O}_6 \cdot \text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 2.66 gms.  $\text{K}_2\text{C}_4\text{H}_4\text{O}_6 \cdot \text{H}_2\text{O}$  at  $0^\circ$ . (Fenton, 1  
100 gms.  $\text{H}_2\text{O}$  dissolve 2.70 gms.  $\text{KHC}_4\text{H}_4\text{O}_6 \cdot \text{H}_2\text{O}$  at  $0^\circ$ . "

F.-pt. data for mixtures of *d* and *l* dimethyl ester of potassium bitartrate  
for mixtures of *d* and *l* diacetyl dimethylester of potassium bitartrate are given  
Adriani (1900).

**POTASSIUM TELLURATE**  $\text{K}_2\text{TeO}_4$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 8.82 gms.  $\text{K}_2\text{TeO}_4$  at  $0^\circ$ , 27.53 gms. at  $20^\circ$  and 50.42 g  
at  $30^\circ$ . (Rosenheim and Weinheber, 1910)

**POTASSIUM THIOCYANATE**  $\text{KSCN}$ .

## SOLUBILITY IN WATER.

t°.	Gms. KSCN per 100 Gms. Sat. Sol.	Solid Phase.	Authority.
- 6.5	16.7	Ice	(Rüdorff, 1872.)
- 9.55	23.1	"	"
- 31.2 Eutec.	50.25	" + KSCN	(Wassiljew, 1910.)
0	63.9	KSCN	
20	68.5	"	(Rüdorff, 1869.)
25	70.5	"	(Foote, 1903.)



## 567 POTASSIUM THIOCYANATE

SOLUBILITY OF MIXTURES OF POTASSIUM THIOCYANATE AND SILVER  
THIOCYANATE IN WATER AT 25°.

(Foote, 1903.)

Gms. Solution.	Mols. per 100 Mols. H <sub>2</sub> O.		Solid Phase.
AgSCN.	KSCN.	AgSCN.	
...	44.36	...	KSCN
9.32	51.13	4.19	KSCN + $\alpha$ KSCN.AgSCN
10.62	47.98	4.60	Double Salt. $\alpha$ KSCN.AgSCN = 53.92% KSCN
11.76	42.07	4.72	
13.55	38.47	5.23	
17.53	33.71	6.50	$\alpha$ KSCN.AgSCN + KSCN.AgSCN
20.43	32.52	7.67	
20.32	30.29	7.28	Double Salt. KSCN.AgSCN = 36.9% KSCN
18.34	12.26	4.05	
16.41	7.77	3.02	
16.07	7.36	2.90	KSCN.AgSCN + AgSCN

## SOLUBILITY OF POTASSIUM THIOCYANATE IN ACETONE, AMYL ALCOHOL, ETC.

(von Laszynyaki, 1894.)

## SOLUBILITY OF POTASSIUM THIOCYANATE IN ACETONE, AMYL ALCOHOL, ETC.

one. In Amyl Alcohol.			In Ethyl Acetate.			In Pyridine.		
gms. KCN per 100 Gms. CO.	t°.	Gms. KSCN per 100 Gms. C <sub>5</sub> H <sub>11</sub> OH.	t°.	Gms. KSCN per 100 Gms. CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub> .	t°.	Gms. KSCN per 100 Gms. C <sub>5</sub> H <sub>5</sub> N.		
75	13	0.18	0	0.44	0	6.75		
40	65	1.34	14	0.40	20	6.15		
	100	2.14	79	0.20	58	4.97		
	133.5	3.15			97	3.88		
					115	3.21		

SOLUBILITY OF POTASSIUM THIOCYANATE IN PYRIDINE, DETERMINED BY  
THE SYNTHETIC METHOD.

(Wagner and Zerner, 1911.)

Gms. KSCN per 100 Gms. Mixture.	Solid Phase.	t°.	Gms. KSCN per 100 Gms. Mixture.	Solid Phase.
0	C <sub>5</sub> H <sub>5</sub> N	70-71	1.23	KSCN
0.5	"	116-117	0.89	"
1.33	"	172.7	at this temperature two liquid layers appear and do not become homogeneous up to 200°.	
2.4	"			
ec. 3.1	" + KSCN			
2.2	KSCN	173.8 m. pt.	100	KSCN

anhydrous acetonitrile dissolve 11.31 gms. KSCN at 18°.

(Naumann and Schlier, 1914.)

See also data for mixtures of KSCN + NaSCN and KSCN + RbSCN  
Wrzcanewsky (1912).



**POTASSIUM THIOSULFATE** 568

**POTASSIUM THIOSULFATE**  $K_2S_2O_3$ .

SOLUBILITY IN WATER. (Jo, 1911, 1912.)

t°.	Gms. $K_2S_2O_3$ per 100 Gms. $H_2O$ .	Solid Phase.	t°.	Gms. $K_2S_2O_3$ per 100 Gms. $H_2O$ .	Solid Phase.
0	96.1	$K_2S_2O_3 \cdot 2H_2O$	56.1	234.5	$K_2S_2O_3 \cdot H_2O + 3K_2SO_4 \cdot H_2O$
17	150.5	$3K_2S_2O_3 \cdot 5H_2O$	60	238.3	$3K_2SO_4 \cdot H_2O$
20	155.4	"	65	245.8	"
25	165	"	70	255.2	"
30	175.7	"	75	268	"
35	202.4	" + $K_2S_2O_3 \cdot H_2O$	78.3	292	" + $K_2SO_4$
40	204.7	$K_2S_2O_3 \cdot H_2O$	80	293.1	$K_2SO_4$
45	208.6	"	85	298.5	"
50	215.2	"	90	312	"
55	227.7	"			

**POTASSIUM Sodium THIOSULFATE**  $KNaS_2O_3 \cdot 2H_2O$ .

100 gms.  $H_2O$  dissolve 213.7 gms.  $KNaS_2O_3 \cdot 2H_2O$  (a) at 15°. (Schwicker, 1889.)  
100 gms.  $H_2O$  dissolve 205.3 gms.  $KNaS_2O_3 \cdot 2H_2O$  (b) at 15°.

**POTASSIUM FluorOTITANATE**  $K_2TiF_6 \cdot H_2O$ .

SOLUBILITY IN WATER. (Marignac, 1866.)

t°.	0°.	3°.	6°.	10°.	14°.	20°.
Gms. $K_2TiF_6$ per 100 gms. $H_2O$	0.55	0.67	0.77	0.91	1.04	1.28

**POTASSIUM VANADATE**  $K_3V_2O_7 \cdot 5H_2O$ .

100 gms.  $H_2O$  dissolve 19.2 gms. at 17.5°. (Radan, 1889.)

**POTASSIUM ZINC VANADATE**  $KZnV_2O_7 \cdot 8H_2O$ .

100 gms.  $H_2O$  dissolve 0.41 gm. of the salt (Radan).

**PRASEODYMIUM CHLORIDE**  $PrCl_3$ .

SOLUBILITY IN WATER, AQ. HYDROCHLORIC ACID AND IN PYRIDINE.  
(Matignon, 1906, 1909.)

Solvent.	t°.	Sp. Gr. Sat. Sol.	Gms. per 100 Gms. Sat. Sol.
Water	13	1.687	50.96 $PrCl_3$
Aq. HCl	13	1.574	41.05 $PrCl_3 + 7.25 HCl$
Pyridine	room temp.	...	2.1 $PrCl_3$

**PRASEODYMIUM GLYCOLATE**  $Pr_2(C_2H_3O_3)_3$ .

One liter water dissolves 3.578 gms.  $Pr_2(C_2H_3O_3)_3$  at 20°. (Jantsch & Grünkraut.)

**PRASEODYMIUM MOLYBDATE**  $Pr_2(MoO_4)_3$ .

One liter water dissolves 0.0152 gm.  $Pr_2(MoO_4)_3$  at 23° and 0.0143 gms. at 25°. (Hitchcock.)

**PRASEODYMIUM Double NITRATES**

SOLUBILITY AT 16° IN CONC.  $HNO_3$  OF  $d_{16} = 1.325$ . (Jantsch, 1912.)

Salt.	Formula.	Gms. $H_2O$ per 100 Gms. Sat. Sol.
Praseodymium Magnesium Nitrate	$[Pr(NO_3)_6]_2Mg_3 \cdot 24H_2O$	7.7
" Nickel	" $Ni_3$ "	9.28
" Cobalt	" $Co_3$ "	12.99
" Zinc	" $Zn_3$ "	14.69
" Manganese	" $Mn_3$ "	23.40



**PRASEODYMIUM OXALATE**  $\text{Pr}_2(\text{C}_2\text{O}_4)_3 \cdot 10\text{H}_2\text{O}$ .

Water dissolves 0.00074 gm.  $\text{Pr}_2(\text{C}_2\text{O}_4)_3$  at  $25^\circ$ . (Rimbach and Schubert, 1909.)  
 ns. aq. 19.4%  $\text{HNO}_3$  ( $d = 1.116$ ) dissolve 1.16 gms.  $\text{Pr}_2(\text{C}_2\text{O}_4)_3$  at  $15^\circ$ .  
 ns. aq. 10.2%  $\text{HNO}_3$  ( $d = 1.063$ ) dissolve 0.50 gm.  $\text{Pr}_2(\text{C}_2\text{O}_4)_3$  at  $15^\circ$ .  
 (v. Scheele, 1899.)

**PRASEODYMIUM Dimethyl PHOSPHATE**  $\text{Pr}_2[(\text{CH}_3)_2\text{PO}_4]_3$ .

ns.  $\text{H}_2\text{O}$  dissolve 64.1 gm.  $\text{Pr}_2[(\text{CH}_3)_2\text{PO}_4]_3$  at  $25^\circ$ . (Morgan and James, 1914.)

**PRASEODYMIUM SULFATE**  $\text{Pr}_2(\text{SO}_4)_3$ .

SOLUBILITY IN WATER. (Muthmann and Rölzig, 1898.)

Gms. $\text{Pr}_2(\text{SO}_4)_3$ per 100 Gms.		Solid Phase.	$t^\circ$ .	Gms. $\text{Pr}_2(\text{SO}_4)_3$ per 100 Gms.		Solid Phase.
Solution.	Water.			Solution.	Water.	
16.5	19.8	$\text{Pr}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$	75	4.0	4.2	$\text{Pr}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$
12.3	14.1	"	85	1.5	1.55	$\text{Pr}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O} +$ $\text{Pr}_2(\text{SO}_4)_3 \cdot 5\text{H}_2\text{O}$
9.4	10.4	"				
6.6	7.1	"	95	1.0	1.01	$\text{Pr}_2(\text{SO}_4)_3 \cdot 5\text{H}_2\text{O}$

**PRASEODYMIUM SULFONATES**

SOLUBILITY IN WATER.

Praseodymium Salt of:	Formula.	Gms. Anhy- drous Salt per 100 Gms. $\text{H}_2\text{O}$ .	Authority.
nitrobenzene Sulfonic Acid	$\text{Pr}(\text{C}_6\text{H}_5\text{Br} \cdot \text{NO}_2 \cdot \text{SO}_3)_{1,4,2} \cdot 8\text{H}_2\text{O}$	6.08	(Katz & James, '13.)
Sulfonic Acid	$\text{Pr}(\text{C}_6\text{H}_5\text{SO}_3)_3 \cdot 9\text{H}_2\text{O}$	55.6	(Holmberg, 1907.)
benzene Sulfonic Acid	$\text{Pr}[\text{C}_6\text{H}_4(\text{NO}_2)\text{SO}_3]_3 \cdot 6\text{H}_2\text{O}$	33.9	"
chlorobenzene Sulfonic Acid	$\text{Pr}[\text{C}_6\text{H}_4\text{Cl} \cdot \text{SO}_3]_3 \cdot 9\text{H}_2\text{O}$	12.6	"
nitrobenzene Sulfonic Acid	$\text{Pr}(\text{C}_6\text{H}_5\text{SO}_3 \cdot \text{NO}_2 \cdot \text{Cl})_{1,3,6} \cdot 14\text{H}_2\text{O}$	25.9	"
toluene Sulfonic Acid	$\text{Pr}[\text{C}_6\text{H}_4\text{SO}_3]_3 \cdot 6\text{H}_2\text{O}$	6.1	"
naphthalene Sulfonic Acid	$\text{Pr}[\text{C}_{10}\text{H}_7(\text{NO}_2)\text{SO}_3]_3 \cdot 6\text{H}_2\text{O}$	0.47	"
"	" . $9\text{H}_2\text{O}$	0.18	"
"	" . $11\text{H}_2\text{O}$	1.3	"

**PRASEODYMIUM TUNGSTATE**  $\text{Pr}_2(\text{WO}_4)_3$ .

Water dissolves 0.0438 gm.  $\text{Pr}_2(\text{WO}_4)_3$  at  $75^\circ$ . (Hitchcock, 1895.)

**PRASEODYMIUM ACID**  $\text{C}_3\text{H}_7\text{COOH}$ .

SOLUBILITY IN WATER, DETERMINED BY THE FREEZING-POINT METHOD.  
 (Faucon, 1910.)

$t^\circ$ .	Gms. $\text{C}_3\text{H}_7\text{COOH}$ per 100 Gms. Sol.	Solid Phase.	$t^\circ$ of Solidif.	Gms. $\text{C}_3\text{H}_7\text{COOH}$ per 100 Gms. Sol.	Solid Phase.
33	4.98	Ice	-17.2	73.48	Ice
60	10.11	"	-21	81.75	"
76	15	"	-29.10	86.85	"
10	25	"	-29.40	87.65	" + $\text{C}_3\text{H}_7\text{COOH}$
70	35.28	"	-28.30	89.12	$\text{C}_3\text{H}_7\text{COOH}$
20	45.20	"	-26.90	92.40	"
80	55	"	-23.90	97.22	"
20	65.88	"	-19.30	100	"

Additional data for this system are given by Tsakalatos (1914), Herz (1917) and (1910). The last-named investigator also determined the composition of the liquid phases and explains the abnormal freezing-point lowering on the basis of the formation of mix-crystals.

The ratio of distribution of propionic acid between water and benzene was determined by King and Narracott (1909) to be 1:0.129 at room temperature.



DISTRIBUTION OF PROPIONIC ACID BETWEEN ETHER AND AQUEOUS SOLUTIONS AT 18°. (de Kolosovsky, 1911.)

Aq. Salt Solution (2 Mols. per Liter).		C <sub>2</sub> H <sub>5</sub> COOH per 100 cc. of:	
Salt.	Gms. Salt per 100 cc.	Aq. Layer (g).	Ether Layer (g).
Water alone		1.170	2.305
NaCl	11.69	0.762	2.543
MgCl <sub>2</sub>	19.05	0.567	3.135
KNO <sub>3</sub>	20.22	0.972	2.298
KC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	22.43	1.324	2.406

β IodoPROPIONIC ACID CH<sub>2</sub>I.CH<sub>2</sub>.COOH.

One liter sat. solution in water contains 80 gms. CH<sub>2</sub>I.CH<sub>2</sub>.COOH at 25°.

One liter sat. solution in 1 n aq. sodium β iodopropionate contains 12.6 gms. at 25°. (Sidgwick, 1910.)

β PhenylPROPIONIC ACID (Hydrocinnamic Acid) CH<sub>2</sub>(C<sub>6</sub>H<sub>5</sub>).CH<sub>2</sub>.COOH.

SOLUBILITY IN WATER AND IN AQ. NORMAL SODIUM β PHENYLPROPIONATE. (Sidgwick, 1910.)

Solvent.	Gms. CH <sub>2</sub> (C <sub>6</sub> H <sub>5</sub> ).CH <sub>2</sub> .COOH per Liter Solution at:	
	11°.	25°.
Water	4.80	7.5
1 n aq. CH <sub>2</sub> (C <sub>6</sub> H <sub>5</sub> ).CH <sub>2</sub> .COONa	7.65	172.5 (liquid layers formed)

SOLUBILITY OF β PHENYLPROPIONIC ACID IN WATER AND IN ALCOHOLS. (Timofeiew, 1894.)

Alcohol.	t°.	Gms. CH <sub>2</sub> (C <sub>6</sub> H <sub>5</sub> ).CH <sub>2</sub> .COOH per 100 Gms. Sat. Solution.	Alcohol.	t°.	Gms. CH <sub>2</sub> (C <sub>6</sub> H <sub>5</sub> ).CH <sub>2</sub> .COOH per 100 Gms. Sat. Solution.
Water	19	0.7	Ethyl Alcohol	+19.6	77.2
Methyl Alcohol	-18.5	55.8	" "	20	78.8
" "	-16	57.6	Propyl Alcohol	-18.5	35
" "	0	66.9	" "	-16	39
" "	+19.6	82.8	" "	+19.6	73.4
" "	20	83.8	" "	20	73.9
Ethyl	-18.5	46	Isobutyl Alcohol	19.6	67.3
" "	-16	48			

SOLUBILITY OF β PHENYLPROPIONIC ACID IN SEVERAL SOLVENTS. (Herz and Rathmann, 1913.)

Solvent.	CH <sub>2</sub> (C <sub>6</sub> H <sub>5</sub> ).CH <sub>2</sub> .COOH per Liter.		Solvent.	CH <sub>2</sub> (C <sub>6</sub> H <sub>5</sub> ).CH <sub>2</sub> .COOH per Liter.	
	Mols.	Gms.		Mols.	Gms.
Chloroform	5.444	817.2	Tetrachloro Ethylene	4.725	709.2
Carbon Tetrachloride	4.604	691.1	Tetrachloro Ethane	5.430	815.1
Trichloro Ethylene	5.140	771.6	Pentachloro Ethane	5.019	753.4

β Phenyl DibromoPROPIONIC ACID C<sub>2</sub>H<sub>2</sub>Br<sub>2</sub>(C<sub>6</sub>H<sub>5</sub>).COOH.

100 cc. sat. sol. in carbon tetrachloride contain 0.124 gm. acid at 26°. (De Jong, 1909.)  
100 cc. sat. sol. in petroleum ether contain 0.072 gm. acid at 26°.

PhenylPROPIOLIC ACID C<sub>6</sub>H<sub>5</sub>C : C.COOH.

SOLUBILITY IN SEVERAL SOLVENTS. (Herz and Rathmann, 1913.)

Solvent.	C <sub>6</sub> H <sub>5</sub> C : C.COOH per Liter.		Solvent.	C <sub>6</sub> H <sub>5</sub> C : C.COOH per Liter.	
	Mols.	Gms.		Mols.	Gms.
Chloroform	0.789	115.30	Tetrachloro Ethylene	0.324	47.34
Carbon Tetrachloride	0.227	33.16	Tetrachloro Ethane	0.718	104.00
Trichloro Ethylene	0.382	55.82	Pentachloro Ethane	0.410	59.91

PROPIONIC ALDEHYDE C<sub>2</sub>H<sub>5</sub>COH.

100 gms. H<sub>2</sub>O dissolve 16 gms. aldehyde at 20°.

(Vaubel, 1899.)



**PROPIONITRILE**  $C_3H_5CN$ .

## SOLUBILITY IN WATER.

Analytic method used. See Note, p. 16.

(Rothmund, 1898.)

t°.	Wt. per cent $C_3H_5CN$ in:		t°.	Wt. per cent $C_3H_5CN$ in:	
	Aq. Layer.	$C_3H_5CN$ Layer.		Aq. Layer.	$C_3H_5CN$ Layer.
40	10.7	92.1	95	19.6	78.0
50	11.6	90.5	100	22.4	75.5
60	12.7	88.5	105	26.0	72.1
70	13.2	86.1	110	32.0	66.5
80	14.9	83.4	113.1 (crit. temp.)	48.3	
90	17.6	80.2			

**ESTER** ACETATE, Butyrate and Propionate.

## SOLUBILITY OF EACH IN AQUEOUS ALCOHOL MIXTURES.

(Bancroft — Phys. Rev. 3, 205, '95, calc. from Pfeiffer.)

cc. $H_2O$ Added to Cause Separation * in:			cc. Alcohol in Mixture.	cc. $H_2O$ Added to cause Separation * in.		
P. Acetate.	P. Butyrate.	P. Propionate.		P. Acetate.	P. Butyrate.	P. Propionate.
4.50	1.19	1.58	21	58.71	19.68	27.83
10.48	3.55	4.70	24	∞	23.72	33.75
17.80	6.13	8.35	30		32.10	47.15
26.00	9.05	12.54	36		41.55	63.18
35.63	12.31	17.15	42		51.60	83.05
47.50	15.90	22.27	48		62.40	107.46
			54		73.85	...

\*  $H_2O$  added to cause the separation of a second phase in mixtures of the given amounts of alcohol and portions of propyl acetate, butyrate and propionate.

## SOLUBILITY OF PROPYL ACETATE, FORMATE, AND PROPIONATE IN WATER.

∞.  $H_2O$  dissolve 1.7 gms. propyl acetate at 22°.

(Traube, 1884.)

∞.  $H_2O$  dissolve 2.1 gms. propyl formate at 22°.

"

∞.  $H_2O$  dissolve 0.6 cc. propyl propionate at 25°.

(Bancroft, 1895.)

**PROPYL ALCOHOL**  $C_3H_7OH$ .

Freezing-point data (solubilities, see footnote, p. 1) for mixtures of propyl alcohol and water are given by Pickering (1893). Results for mixtures of iso-propyl alcohol and water are given by Dreyer (1913).

gms. sat. solution of propyl alcohol in liquid carbon dioxide contain 36.5 gms.  $H_2O$  at -24° and 57.5 gms. at -30°.

(Büchner, 1905-06.)

## SOLUBILITY OF PROPYL ALCOHOL WITH MIXTURES OF CHLOROFORM AND

WATER AT 0°.

(Bonner, 1910.)

Notes, pp. 14 and 287.

Composition of Homogeneous Mixtures.

Composition of Homogeneous Mixtures.

CH <sub>2</sub> Cl <sub>2</sub> .	Composition of Homogeneous Mixtures.			Composition of Homogeneous Mixtures.			
	Gms. $H_2O$ .	Gms. $C_3H_7OH$ .	Sp. Gr. of Mixture.	Gms. $CHCl_3$ .	Gms. $H_2O$ .	Gms. $C_3H_7OH$ .	Sp. Gr. of Mixture.
77	0.023	0.304	1.28	0.500	0.50	1.34	0.97
26	0.074	0.631	1.13	0.394	0.606	1.32	0.98
5	0.10	0.76	1.11	0.293	0.707	1.235	0.96
5	0.20	1.06	1.04	0.194	0.806	0.996	0.95
5	0.30	1.20	1.01	0.097	0.903	0.672	0.97
5	0.40	1.30	0.98	0.030	0.97	0.39	0.97



MISCIBILITY OF PROPYL ALCOHOL AT 0° WITH MIXTURES

Carbon Tetrachloride and Water.  
(Bonner, 1910.)

Ethyl Bromide and Water.  
(Bonner, 1910.)

Composition of Homogeneous Mixtures.				Composition of Homogeneous Mixtures.			
Gms. CCl <sub>4</sub> .	Gms. H <sub>2</sub> O.	Gms. C <sub>3</sub> H <sub>7</sub> OH.	Sp. Gr. of Mixture.	Gms. C <sub>2</sub> H <sub>5</sub> Br.	Gms. H <sub>2</sub> O.	Gms. C <sub>3</sub> H <sub>7</sub> OH.	Sp. Gr. of Mixture.
0.975	0.025	0.317	1.31	0.941	0.039	0.36	1.27
0.931	0.069	0.536	1.17	0.912	0.088	0.61	1.25
0.90	0.10	0.65	1.14	0.90	0.10	0.64	1.24
0.80	0.20	0.949	1.07	0.80	0.20	0.85	1.20
0.70	0.30	1.12	1.02	0.70	0.30	1.00	1.16
0.60	0.40	1.20	0.99	0.60	0.40	1.09	1.12
0.499	0.501	1.234	0.98	0.491	0.509	1.124	1.09
0.40	0.60	1.195	0.97	0.40	0.60	1.10	1.07
0.30	0.70	1.13	0.96	0.30	0.70	0.90	1.05
*0.25	0.75	1.06	...	0.20	0.80	0.81	1.04
0.194	0.806	0.912	0.96	0.14	0.86	0.671	1.03
0.100	0.90	0.68	0.96	0.10	0.90	0.56	1.02
0.013	0.987	0.354	0.96	*0.023	0.977	0.227	1.00

See Notes, pp. 14 and 287.

MISCIBILITY OF PROPYL ALCOHOL AT 0° WITH MIXTURES OF:

Bromobenzene and Water. (Bonner, 1910.)

Bromotoluene and Water. (Bonner, 1910.)

Composition of Homogeneous Mixtures.				Composition of Homogeneous Mixtures.			
Gms. C <sub>6</sub> H <sub>5</sub> Br.	Gms. H <sub>2</sub> O.	Gms. C <sub>3</sub> H <sub>7</sub> OH.	Sp. Gr. of Mixture.	Gms. C <sub>6</sub> H <sub>4</sub> CH <sub>3</sub> Br.	Gms. H <sub>2</sub> O.	Gms. C <sub>3</sub> H <sub>7</sub> OH.	Sp. Gr. of Mixture.
0.983	0.017	0.186	1.29	0.968	0.032	0.252	1.23
0.909	0.091	0.56	1.11	0.90	0.10	0.52	1.11
0.90	0.10	0.58	1.11	0.80	0.20	0.78	1.03
0.80	0.20	0.87	1.05	0.70	0.30	0.96	1.01
0.70	0.30	1.05	1.02	0.60	0.40	1.07	0.99
0.60	0.40	1.15	1	0.50	0.50	1.13	0.97
0.50	0.50	1.19	0.97	0.40	0.60	1.13	0.96
0.40	0.60	1.19	0.97	0.30	0.70	1.03	0.95
0.30	0.70	1.09	0.95	*0.25	0.75	0.97	...
0.20	0.80	0.93	0.95	0.20	0.80	0.90	0.94
0.10	0.90	0.71	0.96	0.10	0.90	0.72	0.93
0.021	0.979	0.457	0.98	0.013	0.987	0.424	0.96

See Notes, pp. 14 and 287.

DISTRIBUTION OF PROPYL ALCOHOL BETWEEN WATER AND COTTON-SEED

OIL AT 25°.

(Wroth and Reid, 1916.)

Gms. C <sub>3</sub> H <sub>7</sub> OH per 100 cc.		Ratio.	Gms. C <sub>3</sub> H <sub>7</sub> OH per 100 cc.:		Ratio.
Oil Layer.	H <sub>2</sub> O Layer.		Oil Layer.	H <sub>2</sub> O Layer.	
1.447	8.112	5.60	1.516	10.07	6.64
1.475	8.897	6.10	1.576	10.49	6.65
1.503	9.809	6.53	1.694	10.41	6.14

Data for systems composed of normal propyl alcohol, water and various inorganic salts are given by Timmermans, 1907.

PROPYLAMINE CH<sub>3</sub>.CH<sub>2</sub>.CH<sub>2</sub>.NH<sub>2</sub>.

The solubility of propylamine in water at 60°, determined by an aspiration method using an indifferent gas, is 191 when expressed in terms of the Bunsen absorption coefficient  $\beta$  (see p. 227) and  $l_{60} = 233$  when expressed in terms of the Ostwald solubility expression.  
(Dyer, 1892.)



ent data for mixtures of propylamine and water, isopropylamine  
for dipropylamine and water are given by Pickering (1893).

UTION OF PROPYLAMINES BETWEEN WATER AND TOLUENE.  
(Moore and Winmill, 1912.)

Results at 18°.		Results at 25°.		Results at 32.35°.	
Gm. Equiv. Amine per Liter of Aq. Layer.	Partition Coef.	Gm. Equiv. Amine per Liter of Aq. Layer.	Partition Coef.	Gm. Equiv. Amine per Liter of Aq. Layer.	Partition Coef.
0.0973	5.434	0.03837	4.470	0.0602	3.311
0.0928	5.439	0.04300	4.470	0.0578	3.317
ne 0.0764	0.1185	0.0722	0.0769	0.01168	0.05802
0.0794	0.1188	0.0681	0.0771	0.01199	0.05795
ine 0.0003	0.003	...	...	...	...

**NE HYDROCHLORIDE**  $\alpha$   $\text{NH}_2(\text{C}_3\text{H}_7)_2\text{HCl}$ .

) dissolve 278.2 gms.  $\text{NH}_2(\text{C}_3\text{H}_7)_2\text{HCl}$  at 25°. (Peddle and Turner, 1913.)  
l  $\text{Cl}_3$  dissolve 5.26 gms.  $\text{NH}_2(\text{C}_3\text{H}_7)_2\text{HCl}$  at 25°. (Peddle and Turner, 1913.)

**AMINE HYDROCHLORIDE**  $\text{NH}(\text{C}_3\text{H}_7)_2\text{HCl}$ .

) dissolve 165.3 gms.  $\text{NH}(\text{C}_3\text{H}_7)_2\text{HCl}$  at 25°. (Peddle and Turner, 1913.)  
l  $\text{Cl}_3$  dissolve 47.24 gms.  $\text{NH}(\text{C}_3\text{H}_7)_2\text{HCl}$  at 25°. (Peddle and Turner, 1913.)

**FLORIDE, Bromide, etc.**

SOLUBILITY IN WATER.

(Rex, 1906.)

Compound.	Grams P. Compound per 100 Gms $\text{H}_2\text{O}$ at:			
	0°.	10°.	20°.	30°.
$\text{CH}_3\text{Cl}$ (normal)	0.376	0.323	0.272	0.277
$\text{CH}_3\text{Br}$ "	0.298	0.263	0.245	0.247
$\text{CH}_3\text{I}$ "	0.114	0.103	0.107	0.103
$\text{HCl}$ (iso)	0.440	0.363	0.305	0.304
$\text{HBr}$ "	0.418	0.365	0.318	0.318
$\text{HI}$ "	0.167	0.143	0.140	0.134

l  $\text{C}_3\text{H}_6$ .

SOLUBILITY IN WATER.

(Than, 1862.)

t°.	$\beta$ .	g.
0	0.4465	0.0834
5	0.3493	0.06504
10	0.2796	0.0519
15	0.2366	0.0437
20	0.2205	0.0405

of  $\beta$  and  $g$ , see Ethane, p. 285.

$\text{H}_2$

SOLUBILITY IN TOLUENE AND IN ABSOLUTE ALCOHOL.

uene dissolve 16.54 gms. pyrene at 18°.

bsolute alcohol dissolve 1.37 gms. pyrene at 10° and 3.08 gms. at



PYRIDINE  $\text{CH} < (\text{CH}.\text{CH})_2 > \text{N}$ .

SOLUBILITY IN WATER, DETERMINED BY THE FREEZING-POINT METHOD.  
(Average curve from results of Pickering (1893) and Baud (1909).)

t° of Solidi- fication.	Gms. $\text{C}_5\text{H}_5\text{N}$ per 100 Gms. Mixture.	Solid Phase.	t° of Solidi- fication.	Gms. $\text{C}_5\text{H}_5\text{N}$ per 100 Gms. Mixture.	Solid Phase.	t° of Solidi- fication.	Gms. $\text{C}_5\text{H}_5\text{N}$ per 100 Gms. Mixture.	Solid Phase.
0	0	Ice	-10	58.5	Ice	-60	84	Ice
-1	7.5	"	-12.5	62	"	-65	Eutec.	85 " + $\text{C}_5\text{H}_5\text{N}$
-2	17	"	-15	64.5	"	-60	87	$\text{C}_5\text{H}_5\text{N}$
-3	28	"	-20	68	"	-55	89	"
-4	37.5	"	-25	71	"	-50	92	"
-5	43.5	"	-30	73.5	"	-45	95	"
-6	48	"	-40	78	"	-40	97	"
-8	54	"	-50	81.5	"	-38 m. pt.	100	"

Timmermans (1912) is reported to have made determinations on the above systems but the original paper could not be located.

Baud also gives data for the densities of pyridine + water mixtures.

## DISTRIBUTION OF PYRIDINE BETWEEN WATER AND BENZENE.

At Room Temperature. (v. Georgievica, 1915.)		At 25°. (Hantzsch and Sebaldt, 1899.)		Ratio.
Gms. $\text{C}_5\text{H}_5\text{N}$ per		Mols. $\text{C}_5\text{H}_5\text{N}$ per Liter.		
25 cc. $\text{H}_2\text{O}$ Layer.	75 cc. $\text{C}_6\text{H}_6$ Layer.	Aq. Layer.	$\text{C}_6\text{H}_6$ Layer.	
0.0617	0.4733	0.00148	0.00436	0.339
0.0958	0.7631	0.00076	0.00226	0.339
0.1549	1.2249	0.00038	0.00110	0.345
0.2432	2.0096	0.000208	0.000546	0.381
0.3297	2.6553	0.000112	0.000274	0.413
0.723	5.4159	(at 5.5°) 0.000456	0.000928	0.491
1.147	9.878	(at 50°) 0.000314	0.001088	0.289

DISTRIBUTION OF PYRIDINE BETWEEN WATER AND TOLUENE.  
(Hantzsch and Vagt, 1901.)

At 25°.			At Various Temperatures.			
Mols. $\text{C}_5\text{H}_5\text{N}$ per Liter.		Ratio.	t°.	Mols. $\text{C}_5\text{H}_5\text{N}$ per Liter.		Ratio.
Aq. Layer.	$\text{C}_6\text{H}_5\text{CH}_3$ Layer.			Aq. Layer.	$\text{C}_6\text{H}_5\text{CH}_3$ Layer.	
0.0517	0.1129	0.458	0	0.0168	0.0201	0.840
0.0261	0.0559	0.466	10	0.0135	0.0215	0.627
0.0132	0.0275	0.481	20	0.0111	0.0228	0.529
0.0067	0.0137	0.496	30	0.0108	0.0234	0.461
0.0033	0.0066	0.551	40	0.0101	0.0245	0.411
0.0019	0.0034	0.629	50	0.0096	0.0252	0.380
0.0011	0.0017	0.647	70	0.0085	0.0263	0.324
0.0007	0.0010	0.696	90	0.0082	0.0266	0.307

Data for systems composed of pyridine, water and various inorganic salts are given by Timmermans, 1907.

## Methyl PYRIDINES

Data for the reciprocal solubility of 3 methyl pyridine (=  $\beta$  picoline) and water, 2,6 dimethyl pyridine (= 2,6 lutidine) and water, methyl pyridine (=  $\gamma$  picoline) zinc chloride and water, methyl pyridine zinc chloride and each of the following alcohols; methyl, ethyl, propyl, isobutyl, isoamyl, cetyl and methyl hexylcarbinol, determined by the synthetic method (see Note, p. 16), are given by Flaschner (1909). See also p. 262, for 2,4,6 trimethyl pyridine (collidine) and water.



**DINO SUCCINIC ACIDS.**

$\text{H}_2\text{O}$  dissolve 1.67 gms. of the *d* compound, 1.64 gms of the *l* compound of the *dl* compound at 18°. (Lutz, 1910.)

**CHOL**  $\text{C}_6\text{H}_4(\text{OH})_2$ .

$\text{H}_2\text{O}$  dissolve 45.1 gms.  $\text{C}_6\text{H}_4(\text{OH})_2$  at 20°. (Vaubel, 1899.)  
 Pyridine dissolve an unlimited amount of  $\text{C}_6\text{H}_4(\text{OH})_2$  at 20°. (Dehn, 1917.)  
 50% pyridine dissolve 101+ gms. of  $\text{C}_6\text{H}_4(\text{OH})_2$  at 20-25°. "  
 for pyrocatechol + resorcinol are given by Jaeger (1907).

**OL**  $\text{C}_6\text{H}_3(\text{OH})_3$  1, 2, 3.

SOLUBILITY IN WATER, ETC.  
 (U. S. P. VIII.)

Water dissolve 62.5 gms.  $\text{C}_6\text{H}_3(\text{OH})_3$  at 25°.   
 Alcohol dissolve 100 gms.  $\text{C}_6\text{H}_3(\text{OH})_3$  at 25°.   
 Ether dissolve 90.9 gms.  $\text{C}_6\text{H}_3(\text{OH})_3$  at 25°.

**TRIONE**  $\text{C}_7\text{H}_6\text{O}_3$ .

Ant data for mixtures of dimethyl pyrone and each of the following salicylic acid, *o*, *m*, *p* and  $\alpha$  toluic acids and trinitrotoluene are given (914a). Results for mixtures of dimethyl pyrone and sulfuric acid Kendall and Carpenter (1914).

**TRIONE**  $\text{C}_4\text{H}_3\text{O}_3 \cdot \text{C}_6\text{H}_4(\text{OH})_2$ .

Water solubility and dissociation of quinhydrone in water at 25° are given by Leubner (1912).

 $\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_7 \cdot ?\text{H}_2\text{O}$ .

## SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. $\text{C}_{20}\text{H}_{24}\text{N}_2\text{O}_7$ per 100.		Authority.
		Gms. Solvent.	cc. Solvent.	
(95%)	18-22	0.020	...	(Müller, 1903.)
	25	...	0.0145	(Schaefer, 1910.)
	20	4	...	(Wherry & Yanovsky, 1918.)
	25	...	2.22	(Schaefer, 1913.)
<i>dl</i>	25	...	0.66	"
	25	...	1.19	"
chloride	18-22	2.45	...	(Müller, 1903.)
	18-22	0.557	...	"
	18-22	100+	...	"
	25	...	25	(Schaefer, 1913.)
12)	18-22	0.78	...	(Müller, 1903.)
	18-22	1.63	...	"
1 H <sub>2</sub> O	18-22	0.031	...	"
	18-22	1.76	...	"
Ether	18-22	0.024	...	"
	18-22	...	...	"
pt. 59°-64°)	18-22	0.024	...	"
+4 vols. $\text{CHCl}_3$	25	...	33.3	(Schaefer, 1913.)
+4 vols. $\text{C}_6\text{H}_6$	25	...	12.5	"
+4 vols. $\text{CHCl}_3$	25	...	25	"
+4 vols. $\text{C}_6\text{H}_6$	25	...	6.6	"

**SALTS**

## SOLUBILITY IN WATER AT 25°.

(Schaefer, 1910.)

Salt.	Gms. Salt per 100 Gms. $\text{H}_2\text{O}$ .	Quinidine Salt.	Gms. Salt per 100 Gms. $\text{H}_2\text{O}$ .
bromide	0.526	Q. Sulfate	1.05
chloride	1.160	Q. Tannate	0.0477
iodide	0.082	Q. Tartrate	2.86
ate	0.060	Q. Bitartrate	0.323



# QUINIDINE SULFATE

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## SOLUBILITY OF QUINIDINE SULFATE IN SEVERAL SOLVENTS AT 25°.

(Schaefer, 1913.)

Solvent.	Gms. Q. Sulfate per 100 cc. Solvent.	Solvent.	Gms. Q. Salt per 100 cc. Solvent.
Ethyl Alcohol	5	1 vol. C <sub>2</sub> H <sub>5</sub> OH + 4 vols. CHCl <sub>3</sub>	33.3
Methyl Alcohol	40	1 vol. C <sub>2</sub> H <sub>5</sub> OH + 4 vols. C <sub>6</sub> H <sub>6</sub>	8.33
Chloroform	8.33	1 vol. CH <sub>3</sub> OH + 4 vols. CHCl <sub>3</sub>	33.3
Benzene	Insol.	1 vol. CH <sub>3</sub> OH + 4 vols. C <sub>6</sub> H <sub>6</sub>	20

# QUININE C<sub>20</sub>H<sub>24</sub>N<sub>2</sub>O<sub>3</sub>·3H<sub>2</sub>O.

## SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Anhydrous Quinine Gms. per 100.		Hydrated Quinine Gms. per 100 Gms. Solvent.	Author
		Gms. Solvent.	cc. Solvent.		
Water	18-22	0.051	...	0.0574 (Müller, 1903.)	
"	25	0.057	0.033	0.065 (U. S. P.; Schaefer)	
"	80	0.123	...	0.129 (U. S. P.)	
Ethyl Alcohol	20	100	...	... (Wherry and Yano)	
"	25	166.6	...	166.6 (U. S. P.)	
"	25	...	1333	... (Schaefer, 1913.)	
Methyl Alcohol	20	...	66.6	...	
Benzene	25	...	0.55	0.205 (Schaefer; Müller,	
"	20	0.5	...	... (Wherry and Yano)	
"	18-22	1.7	...	... (Müller, 1903.)	
Aniline	20	14.5	...	... (Scholtz, 1912.)	
Carbon Tetrachloride	20	0.54	...	0.204 (Gori, 1913; Müller)	
Chloroform	25	50-52.6	...	62.5 (Schaefer, 1913; U.	
"	18-22	100+	...	100+ (Müller, 1903.)	
Diethylamine	20	57	...	... (Scholtz, 1912.)	
Ether	25	22.2	...	76.9 (U. S. P.)	
" (d=0.72)	18-22	0.876	...	1.62 (Müller, 1903.)	
" sat. with H <sub>2</sub> O	18-22	2.8	...	5.62 "	
H <sub>2</sub> O sat. with Ether	18-22	0.085	...	0.067 "	
Ethyl Acetate	18-22	24.7	...	4.65 "	
Petroleum Ether (b. pt. 50°-64°)	18-28	0.021	...	0.010 "	
Oil of Sesame	20	...	0.0453	0.053 (Zalai, 1910.)	
Glycerol	25	0.633	...	0.472 (U. S. P.; Ossendow)	
Piperidine	20	119	...	... (Scholtz, 1912.)	
Pyridine	20	101	...	...	
Aq. 50% Pyridine	20-25	59.4	...	... (Dehn, 1917.)	
7.65 gms. H <sub>2</sub> BO <sub>3</sub> per 100	room				
cc. aq. 50% Glycerol	temp.	20	...	... (Baroni and Barlinet	
15.3 gms. H <sub>2</sub> BO <sub>3</sub> per 100	room				
cc. aq. 50% Glycerol	temp.	40	...	...	

## SOLUBILITY OF QUININE IN BENZENE, DETERMINED BY THE SYNTH (SEALED TUBE) METHOD.

(van Iterson-Rotgans, 1914.)

t°.	Wt. % Quinine.	Solid Phase.	t°.	Wt. % Quinine.	Solid Phase.	t°.	Wt. % Quinine.	Sc
5.4	0	C <sub>6</sub> H <sub>6</sub>	53-5	4.81		137	80	C
5.3*	...	" +	63	6.09	Mixed phase,	142	83.04	
17	0.72	C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>3</sub> ·C <sub>6</sub> H <sub>6</sub>	91	30.01	probably a	146	85.26	
29	1.48	"	102	43.4	colloid or sol-	152	87.44	
38.5	2.36	"	104.5	45.9	ution of high	158.5	91.4	
49	5.22	" unstable	109	51.8	viscosity.	166	95.02	
±70	28.9	" "	130	75.46		174.7	100	

\* Eutec.



TOXICITY OF QUININE IN AQUEOUS SOLUTIONS OF CAUSTIC ALKALIES.  
(Doumer and Deraux, 1895.)

— A one per cent solution of quinine sulfate, containing a very little of HCl, was gradually added to 200 cc. portions of the caustic alkalis of the various concentrations stated, and the point noted at which the first appearance of the precipitate corresponding to that of 1 cc. of milk in 100 cc. of water remained undissolved.

Ammonia.	In Aq. Sodium Hydroxide.		In Aq. Pot. Hydroxide.	
Gms. Anhydrous Quinine Dissolved.	Gms. NaOH per 200 cc. Solution.	Gms. Anhydrous Quinine Dissolved.	Gms. KOH per 200 cc. Solution.	Gms. Anhydrous Quinine Dissolved.
0.084	0.007	0.092	0.612	0.088
0.084	0.012	0.091	1.512	0.082
0.096	0.740	0.090	3.456	0.068
0.122	2.160	0.079	10.944	0.039
0.144	3.188	0.056	44.704	0.006
0.174	6.172	0.044		
0.184	8.537	0.021		
	17.074	0.015		

SOLUBILITY OF QUININE SALTS IN WATER.  
(Regnault and Willejean, 1887.)

alt.	t°.	Gms. Salt per 100 Gms. H <sub>2</sub> O.	Salt.	t°.	Gms. Salt per 100 Gms. H <sub>2</sub> O.
urate (basic)	14	2.06	Salicylate (basic)	15	0.114
(neutral)	12	12.33	Sulfate	14	0.139
"	14	13.19	"	16	0.153
"	16	14.79	"	18	0.160
"	15	14.20	" (neutral)	15	8.50
urate (basic)	12	3.80	"	17	8.90
"	14	4.14	"	18	9.62
"	15	4.25	Valerate (basic)	12-16	2.59
asic)	15	10.03			
"	37	16.18			

SOLUBILITY OF QUININE SALTS IN WATER AT 25°.  
(Schaefer, 1910.)

Salt.	Gms. Salt per 100 Gms. H <sub>2</sub> O.	Salt.	Gms. Salt per 100 Gms. H <sub>2</sub> O.
	2	Hypophosphite	2.85
	0.042	Lactate, basic	16.6
	0.154	Nitrate	1.43
	0.278	Oxalate	0.071
omide	20	Phosphate	0.125
loride	143 (133)	Picrate	0.029
loride + Urea	100	Quinate	28.6
	11.78	Salicylate	0.048
osulfate	77 (50)	Sulfate	0.143
	0.032	Bisulfoguiacolate	200
	0.121 (0.083)	Sulfophenate	0.4
osphate, basic	0.1178 (insol.)	Urate	0.182
nide	2.33	Phenylsulfate	0.147
ride	4.76	Tartrate	0.105
ocyanide	0.05	Tannate	0.05(*)
de	0.49	Valerate	1.25

\* Insol.

It should be noted that different values for the solubility may be obtained depending on the method used for preparing the saturated solution. The values in parentheses are by Squire and Caines (1905), and are for 15°-20° and 5°.



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**SOLUBILITY OF QUININE SALTS IN SEVERAL SOLVENTS.**  
(Phelps and Palmer, 1917.)

Salt.	M. pt. (uncorr.)	Solubility, Parts per 100 Parts Solvent in:			
		CCl <sub>4</sub> .	CHCl <sub>3</sub> . (Alcohol free).	Ethyl Acetate (Alcohol free).	
				Cold.	Hot.
Quinine racemic lactate	165.5	0.00715	28.6	0.286	3.33
" <i>d</i> lactate	175	0.0111	...	0.25	...
" <i>l</i> "	171	0.00476	...	0.20	...
" formate	110-113	0.00625	...	...	...
" acetate	124-126	0.05	...	...	...
" propionate	110-111	0.238	...	...	...
" butyrate	77.5	4	...	...	...
" succinate	192	0.001	...	...	0.4
" tartrate	202.5	0.0004	...	...	0.0333
" malate	177.5	0.0008	...	...	0.5
" citrate	183.5	0.00167	...	...	0.0833
" sulfate	214	0.0025	0.0333	0.00715	0.0133
Quintoxime lactate	...	0.11	...	...	...

Saturation was obtained by shaking at intervals by hand, during 72 hours. In case of the determination at "hot," the solutions were boiled under a reflux condenser for 18 hours.

**QUININE HYDROCHLORIDE**  $C_{20}H_{24}N_2O_3 \cdot HCl \cdot 2H_2O$ .

**SOLUBILITY IN AQUEOUS SALT SOLUTIONS AT 16°.**  
(Tarugi, 1914.)

The determinations were made by adding an aqueous solution of quinine hydrochloride to the aqueous salt solution until turbidity occurred. From the volumes involved, the solubility per 100 cc. was calculated.

In Aq. NaCl.		In Aq. NaNO <sub>3</sub> .		In Aq. KCl.		In Aq. CaCl <sub>2</sub> .	
Gms. per 100 cc. Sol.		Gms. per 100 cc. Sol.		Gms. per 100 cc. Sol.		Gms. per 100 cc. Sol.	
NaCl.	Q.HCl.	NaNO <sub>3</sub> .	Q.HCl.	KCl.	Q.HCl.	CaCl <sub>2</sub> .	Q.HCl.
2.02	2.6	0.677	2.85	2.63	2.545	6.37	1.02
2.49	1.94	0.970	1.96	3	1.882	7.03	0.9
3.40	1.22	2.008	0.67	5.57	0.804	7.75	0.8
8.34	0.54	3.65	0.43	8.26	0.531	7.96	0.7
11.40	0.205	9.31	0.292	10.42	0.407	34.42	0.1
15.56	0.140	19.12	0.168	17.87	0.205		
19.83	0.085	31.78	0.0663	25.74	0.0997		

100 cc. 90% alcohol dissolve 20 gms. Q. bihydrochloride at 15°-20°.

“chloroform

" 90% alcohol  
" " "

" " "

... H.O. disc.

100 gms.  $H_2O$  dissolve 1.3 gms. anhydrous Q. glycerophosphate at  $100^\circ$ .

(Rogier and Fiore —

**QUININE SALICYLATE**  $C_{20}H_{24}N_2O_2 \cdot C_6H_4(OH)COOH \cdot 2H_2O$ .

**SOLUBILITY IN AQUEOUS ALCOHOL AT 25°.**  
(Seidell, 1909, 1910.)

Wt. % $C_2H_5OH$ in Solvent.	$d_{20}$ of Sat. Sol.	Gms. Q. Sal. $2H_2O$ per 100 Gms. Sat. Sol	Wt. % $C_2H_5OH$ in Solvent.	$d_{20}$ of Sat. Sol.	Gms. Q. Sal. $2H_2O$ per 100 Gms. Sat. Sol.
0	0.999	0.065	60	0.896	2.45
10	0.982	0.080	70	0.876	3.25
20	0.966	0.200	80	0.854	4.25
30	0.952	0.48	90	0.832	4.75
40	0.935	1	92.3	0.826	4.85
50	0.916	1.70	100	0.797	3.15



## SOLUBILITY OF QUININE SULFATE IN SEVERAL SOLVENTS AT 25°.

(Schaefer, 1913.)

	Gms. Q. Sulfate per 100 cc. Solvent.	Solvent.	Gms. Q. Sulfate per 100 cc. Solvent.
alcohol	0.4	1 vol. C <sub>2</sub> H <sub>5</sub> OH + 4 vols. CHCl <sub>3</sub>	12.5
alcohol	3.12	1 vol. C <sub>2</sub> H <sub>5</sub> OH + 4 vols. C <sub>6</sub> H <sub>6</sub>	0.53
1	0.27	1 vol. CH <sub>3</sub> OH + 4 vols. CHCl <sub>3</sub>	20
insol.		1 vol. CH <sub>3</sub> OH + 4 vols. C <sub>6</sub> H <sub>6</sub>	4.76

. trichlorethylene dissolve 0.07 gm. Q. sulfate at 15°. (Wester and Bruins, 1914.)

## TANNATES True and False

## SOLUBILITY IN WATER AND IN AQUEOUS HCl AT 37°. (Muraro, 1908.)

Salt.	Formula.	Gms. Q. Tannate per 100 Gms.		
		H <sub>2</sub> O.	Aq. 1% HCl.	Aq. 3% HCl.
ate I	C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>7</sub> ·C <sub>10</sub> H <sub>14</sub> O <sub>9</sub> ·4H <sub>2</sub> O	0	0.984	3.656
ate II	(C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>7</sub> ) <sub>2</sub> ·(C <sub>10</sub> H <sub>14</sub> O <sub>9</sub> ) <sub>2</sub> ·8H <sub>2</sub> O	0	1.210	4.756
ate	(C <sub>20</sub> H <sub>24</sub> N <sub>2</sub> O <sub>7</sub> ·H <sub>2</sub> SO <sub>4</sub> ) <sub>2</sub> ·(C <sub>10</sub> H <sub>14</sub> O <sub>9</sub> ) <sub>2</sub> ·14H <sub>2</sub> O	0.313	0.847	1.560

Work of Muraro is criticized by Biginelli (1908).

0% alcohol dissolve 33.3 gms. Q. tannate at 15°-20°. (Squire and Caines, 1905.)

PYROTARTRATES *l*, *i*, *d*.

## SOLUBILITIES IN ALCOHOL AT 18°. (Ladenburg and Herz, 1898.)

1. alcohol dissolve 15 gms. of the *l* pyrotartrate, 3.2 gms. of the *i* and the *d* compound. The results show that the *i* acid is not a mixture of *d* and *l*, and, therefore, that the *i* quinine compound is a salt of the racemic acid.

## SOLUBILITY OF QUININE AND OF QUININE SALTS IN WATER AND OTHER SOLVENTS. (U. S. P. VIII.)

Compound.	Gms. Quinine Compound per 100 Gms. Solvent in:					
	Water.		Alcohol.	Ether.	Chloroform.	Glycerol.
	At 25°.	At 80°.	At 25°.	At 25°.	At 25°.	At 25°.
1. 3H <sub>2</sub> O	0.057	0.123	166.6	22.2	52.6	0.633
1. HCl·2H <sub>2</sub> O	0.005	0.129	166.6	76.9	62.5	0.472
1. C <sub>6</sub> H <sub>5</sub> (OH).-H <sub>2</sub> O	5.55	250	166.6	0.417	122	12.2
1. 1/2 H <sub>2</sub> SO <sub>4</sub> ·7H <sub>2</sub> O	1.30	2.86	9.09	0.91	2.70	6.25
1. 1/2 H <sub>2</sub> SO <sub>4</sub> ·7H <sub>2</sub> O	0.139	2.22	1.16	...	0.25	2.78
1. HBr·H <sub>2</sub> O	11.77	147	5.55	0.056	0.109	5.55
1. HBr·H <sub>2</sub> O	2.5	33.3	149.2	6.2	...	12.5

QUININE ETHIODIDE C<sub>20</sub>H<sub>21</sub>N·C<sub>2</sub>H<sub>5</sub>I.1. H<sub>2</sub>O dissolve 301.3 gms. C<sub>20</sub>H<sub>21</sub>N·C<sub>2</sub>H<sub>5</sub>I at 25°. (Peddle and Turner, 1913.)1. CHCl<sub>3</sub> dissolve 1.78 gms. C<sub>20</sub>H<sub>21</sub>N·C<sub>2</sub>H<sub>5</sub>I at 25°. "

## EMANATIONS

## SOLUBILITY IN WATER. (Boyle, 1911; Kofler, 1913.)

Solubility.		t°.	Solubility.	
<i>l</i> (Boyle).	$\alpha$ (Kofler).		<i>l</i> (Boyle).	$\alpha$ (Kofler).
0.508	0.54	30	0.195	0.205
0.41	0.442	40	0.16	0.165
0.34	0.37	50	...	0.14
0.29	0.31	60	...	0.12
0.245	0.265	70	...	0.11
0.215	0.232	90	...	0.108

Results of Boyle are in terms of *l*, the Ostwald Solubility Expression (seeThose of Kofler are in terms of the expression  $\alpha = \frac{V-v}{v} \cdot \frac{E'}{E}$ , where

*v* are the volumes involved and *E'* and *E* the total amount of emanation respectively in the air and in the liquid.



## SOLUBILITY IN SEVERAL SOLVENTS.

(Ramstedt, 1911; Swinne, 1913.)

Solvent.	Results at 0°.		Results at 18°.		Results at 14°. (Boyle, 1911.)
	$l_0$	Sp. Gr. of Sol.	$l_{18}$	Sp. Gr. of Sol.	$l_{14}$
Water	0.52	0.9999	0.285	0.9986	0.30
Sea Water	...	...	...	...	0.255
Ethyl Alcohol	8.28	0.8065	6.17	0.7911	7.34
Amyl Alcohol	...	...	...	...	9.31
Acetone	7.99	0.8186	6.30	0.7972	...
Aniline	4.43	1.0379	3.80	1.0210	...
Benzene	...	...	12.82	0.8811	...
Carbon Disulfide	33.4	1.2921	23.14	1.2640	...
Chloroform	20.5	1.5264	15.08	1.4907	...
Cyclohexane	...	...	18.04	0.7306	...
Ethyl Acetate	9.41	0.9244	7.34	0.9029	...
Ethyl Ether	20.9	0.7362	15.08	0.7158	...
Glycerol	...	...	0.21	1.262	...
Hexane	23.4	0.6769	16.56	0.6612	...
Toluene	18.4	0.8842	13.24	0.8666	13.1

The above results are in terms of the Ostwald Solubility Expression (see p. 227).

RESORCINOL  $C_6H_4(OH)_2$ , 1, 3.

## SOLUBILITY IN:

t°.	Water.				Ethyl Alcohol.			
	(Speyers — Am. J. Sci. [4] 14, 294, '02.)				(Speyers.)			
	Sp. Gr. of Solutions.	Gms. $C_6H_4(OH)_2$ per 100 Gms.			Sp. Gr. of Solutions.	Gms. $C_6H_4(OH)_2$ per 100 Gms.		
		Water.	Solution.			Alcohol.	Solution.	
0	1.101	60	37.5		1.033	210	67	7.8
10	1.118	81	44.8		1.036	223	69	9.0
20	1.134	103	50.7		1.041	236	70	10.3
25	1.142	117	53.9		1.045	243	70	10.8
30	1.148	131	56.7		1.048	250	71	11.4
40	1.157	161	58.9		1.056	266	72	12.7
50	1.165	198	66.5		1.065	286	74	14.1
60	1.172	246	71.1		1.075	311	75	15.7
70	1.176	320	76.2		1.087	341	77	17.3
80	1.179	487	82.9		1.104	375	78	18.9

NOTE. — The original results of Speyers are given in terms of mols.  $H_2O$ .

According to Vaubel (1895), 100 gms.  $H_2O$  dissolve 175.5 gms.  $C_6H_4(OH)_2$  or 100 gms. sat. solution contain 63.7 gms. at 20°. Sp. Gr. of sol. = 1.1335.

## SOLUBILITY OF RESORCINOL IN ALCOHOLS AND IN ACIDS.

(Timofeiew, 1894.)

Solvent.	t°.	Gms. $C_6H_4(OH)_2$ per 100 Gms. Sat. Sol.	Solvent.	t°.	Gms. $C_6H_4(OH)_2$ per 100 Gms. Sat. Sol.
Methyl Alcohol	11.6	69	Formic Acid	15	29.2
Ethyl "	10.4	59.2	Acetic "	15	32.5
"	11.6	61.5	Propionic "	15	22.8
Propyl "	10.4	51.5	Butyric "	15	14.7
"	11.6	51.6	Isobutyric "	15	9.6
			Valeric "	15	6.5



## SOLUBILITY OF RESORCINOL IN BENZENE.

(Rothmund, 1898.)

t°.	Gms. $C_6H_4(OH)_2$ per 100 Gms. Sat. Sol.	t°.	Gms. $C_6H_4(OH)_2$ per 100 Gms. Sat. Sol.
73	3.18	95.5	61.7
77	4.75	96.5	77.64
82	6.94	83.46	98.5
95.5	37.44	90.23	100

At the concentrations 37.44 and 61.7 at 95.5° two liquid layers are

The reciprocal solubilities of these two layers, determined by the

ic method (see Note, p. 16), are as follows:

Gms. $C_6H_4(OH)_2$ per 100 Gms.		t°.	Gms. $C_6H_4(OH)_2$ per 100 Gms.	
$C_6H_6$ Layer.	$C_6H_4(OH)_2$ Layer.		$C_6H_6$ Layer.	$C_6H_4(OH)_2$ Layer.
4.8	79.4	90	13	71.3
6.6	77.5	100	19.5	65.7
9.2	75	105	24.6	60.7
		109.3 crit. temp.	42.4	

resorcinol mixes with pyridine in all proportions.

(Dehn, 1917.)

100 ms. aqueous 50% pyridine dissolve 901 gms.  $C_6H_4(OH)_2$  at 20°-25°. "

c. olive oil dissolve 4.55 gms.  $C_6H_4(OH)_2$  at 15°-20°. (Squire and Caines, 1905.)

coefficient of distribution of resorcinol at 25° between olive oil and water

in oil + conc. in  $H_2O$ ) is given as 0.04 by Boeseken and Waterman (1911,

melting-point data (solubility, see footnote, p. 1), for mixtures of resorcinol

and toluidine are given by Philip and Smith (1905) and by Vignon (1891).

for mixtures of resorcinol and *m* xylene are given by Campetti (1917).

## DISTRIBUTION OF RESORCINOL BETWEEN WATER AND ORGANIC SOLVENTS AT ORDINARY TEMPERATURE.

(Vaubel — J. pr. Ch. [2] 67, 478, '03.)

No.	Solvents.	Gms. $C_6H_4(OH)_2$ in:	
		$H_2O$ Layer.	Organic Solvent Layer.
91	60 cc. $H_2O$ + 30 cc. Ether	0.2014	0.9896
91	60 cc. $H_2O$ + 60 cc. Ether	0.2475	0.9525
∞	40 cc. $H_2O$ + 40 cc. Benzene	0.5873	0.2127
∞	40 cc. $H_2O$ + 80 cc. Benzene	0.5773	0.2227
∞	50 cc. $H_2O$ + 50 cc. $CCl_4$	0.4885	0.0115
∞	50 cc. $H_2O$ + 100 cc. $CCl_4$	0.4880	0.0120
∞	50 cc. $H_2O$ + 150 cc. $CCl_4$	0.4880	0.0120

## RUTHENIUM SALTS. SOLUBILITY IN WATER.

(Jorgensen — J. pr. Ch. [2] 27, 433, '83; 34, 394, '86; 44, 51, '91.)

Salt.	Formula.	t°.	Gms. per 100 Gms. $H_2O$
Purpureo Rhodium Chloride	$ClRh(NH_3)_4Cl_2$	17	0.56
Rhodium Chloride	$Rh(NH_3)_4Cl_3$	8	13.3
Rhodium Nitrate	$Rh(NH_3)_4(NO_3)_3$	ord. t.	2.1
Rhodium Sulphate	$[Rh(NH_3)_4]_2(SO_4)_3 \cdot 5H_2O$	20	2.3

RUTHENIUM  $C_{20}H_{21}N_3O_4$ .

100 ms.  $H_2O$  dissolve 0.03 gm.  $C_{20}H_{21}N_3O_4$  at 20°-25°.

(Dehn, 1917.)

100 ms. pyridine dissolve 41.5 gms.  $C_{20}H_{21}N_3O_4$  at 20°-25°.

"

100 ms. aq. 50% pyridine dissolve 35.1 gms.  $C_{20}H_{21}N_3O_4$  at 20°-25°.

"



Triphenyl *p* **ROSANILINE HYDROCHLORIDE** (C<sub>18</sub>H<sub>15</sub>N<sub>3</sub>Cl)

SOLUBILITY IN SEVERAL SOLVENTS AT 23°.  
(v. Szathmary de Szachmar, 1910.)

Solvent.	Gms. Triphenyl <i>p</i> Rosaniline HCl per 100 Gms. Sat. Sol.
Methyl Alcohol	0.447
Ethyl " "	0.285
Amyl " "	0.11
Acetone	0.19
Aniline	0.518

**ROSOLIC ACID** C<sub>20</sub>H<sub>16</sub>O<sub>3</sub>.

100 gms. H<sub>2</sub>O dissolve 0.12 gm. C<sub>20</sub>H<sub>16</sub>O<sub>3</sub> at 20°-25°.  
100 gms. pyridine dissolve 160 gm. C<sub>20</sub>H<sub>16</sub>O<sub>3</sub> at 20°-25°.  
100 gms. aq. 50% pyridine dissolve 80 gm. C<sub>20</sub>H<sub>16</sub>O<sub>3</sub> at 20°-25°.

(Dehmer, 1917.)

**RUBIDIUM ALUMS.** See also Alums, p. 32.

SOLUBILITY IN WATER.  
(Locke, 1901.)

Alum.	Formula.	t°.	Gms. Alum per 100 Gms. H <sub>2</sub> O.			
			Anhydrous.	Hydrated.	G	Mol.
Rb. Aluminum Alum	RbAl(SO <sub>4</sub> ) <sub>2</sub> ·12H <sub>2</sub> O	25	1.81	3.15	0.0059	
"	"	30	2.19	...	0.0072	
"	"	35	2.66	...	0.0087	
"	"	40	3.22	...	0.0106	
Rb. Chromium Alum	RbCr(SO <sub>4</sub> ) <sub>2</sub> ·12H <sub>2</sub> O	25	2.57	4.34	0.0079	
"	"	30	3.17	...	0.0096	
"	"	35	4.11	...	0.0128	
"	"	40	5.97	...	0.0181	
Rb. Vanadium Alum	RbV(SO <sub>4</sub> ) <sub>2</sub> ·12H <sub>2</sub> O	25	5.79	9.93	0.0177	
Rb. Iron Alum	RbFe(SO <sub>4</sub> ) <sub>2</sub> ·12H <sub>2</sub> O	25	9.74	16.98	0.0294	
"	"	30	20.24	...	0.0617	

Biltz and Wilke, 1906, find for the solubility of rubidium iron alum in water, at 6.6°, 4.55 gms. per 100 cc. solution; at 25°, 29 gms; and at 40°, 52.6 gms.

**RUBIDIUM FLUOBORIDE** RbBF<sub>4</sub>.

100 gms. H<sub>2</sub>O dissolve 0.55 gm. RbBF<sub>4</sub> at 20°, and 1 gm. at 100°. (Godeffroy - 1876)

**RUBIDIUM BROMIDE** RbBr.

SOLUBILITY IN WATER.  
(Rimbach, 1905.)

t°.	Gms. RbBr per 100 Gms.			Gms. RbBr per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0.5	89.6	47.26	39.7	131.85	56 - 87
5	98	49.50	57.5	152.47	60 - 39
16	104.8	51.17	113.5	205.21	67 - 24

Freezing-point data for RbBr + AgBr are given by Sandonnini (1912a)-

**RUBIDIUM BICARBONATE** RbHCO<sub>3</sub>.

100 gms. sat. solution in H<sub>2</sub>O contain 53.73 gms. RbHCO<sub>3</sub> at about 20°.  
(de Forcrand, 1909.)

**RUBIDIUM CARBONATE** Rb<sub>2</sub>CO<sub>3</sub>.

100 gms. absolute alcohol dissolve 0.74 gm. Rb<sub>2</sub>CO<sub>3</sub>.

(Bunsen.)



**TRIUM CHLORATE  $\text{RbClO}_3$ .****SOLUBILITY IN WATER.**  
(Calzolari, 1912.)

t°.	Gms. $\text{RbClO}_3$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{RbClO}_3$ per 100 Gms. $\text{H}_2\text{O}$ .
0	2.138	42.2	12.48
8	3.07	50	15.98
19.8	5.36	76	34.12
30	8	99	62.8

is some uncertainty as to whether the results of Calzolari refer to 100  $\text{H}_2\text{O}$  or 100 gms. of saturated solution.

na.  $\text{H}_2\text{O}$  dissolve 3.1 gms.  $\text{RbClO}_3$  at 15° ( $d_{15}$  of the sat. sol. = 1.07). (Carlson, '10.)  
earlier data see Reissig, 1863.

**DIUM PerCHLORATE  $\text{RbClO}_4$ .****SOLUBILITY IN WATER.**  
(Carlson, 1910; Calzolari, 1912.)

Gms. $\text{RbClO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .		t°.	Gms. $\text{RbClO}_4$ per 100 Gms. $\text{H}_2\text{O}$	
(Calzolari.)	(Carlson.)		(Calzolari.)	(Carlson.)
0.5	1.1 (1.007)	50	3.5	4.6
0.6	1.2	60	4.85	6.27 (1.028)
1	1.56 (1.010)	70	6.72	8.2
1.2	1.8	80	9.2	11.04 (1.050)
1.5	2.2	90	12.7	15.5
2.3	3.26 (1.017)	100	18	22 (?) (1.070)

figures in parentheses are densities of sat. solutions.  
gms.  $\text{H}_2\text{O}$  dissolve 1.08 gm.  $\text{RbClO}_4$  at 21.3°.

(Longuimine, 1862.)

**DIUM Potassium PerCHLORATE  $\text{Rb}_2\text{K}(\text{ClO}_4)_3$ .**

gms. sat. solution in  $\text{H}_2\text{O}$  contain 1.55 gms.  $\text{Rb}_2\text{K}(\text{ClO}_4)_3$  at 20° ( $d_{20}$  of the solution = 1.013). (Carlson, 1910.)

**DIUM CHLORIDE  $\text{RbCl}$ .****SOLUBILITY IN WATER.**  
(Rimbach, 1902; Berkeley, 1904.)

Mols. $\text{RbCl}$ per Liter.	Gms. $\text{RbCl}$ per 100 Gms.		t°.	Mols. $\text{RbCl}$ per Liter.	Gms. $\text{RbCl}$ per 100 Gms.	
	Water.	Solution.			Water.	Solution.
5.17	77.0	43.5	60	6.90	115.5	53.6
5.55	84.4	45.8	70	7.12	121.4	54.8
5.88	91.1	47.7	80	7.33	127.2	56.0
6.17	97.6	49.4	90	7.52	133.1	57.1
6.43	103.5	50.9	100	7.71	138.9	58.9
6.67	109.3	52.2	112.9	7.95	146.6	59.5

Following determinations of the Sp. Gr. of the sat. solutions are given by

	0.55	18.7	31.5	44.7	60.25	75.15	89.35	114*
t.	1.4409	1.4865	1.5118	1.5348	1.5558	1.5746	1.5905	1.6148

\* Boiling-point.

gms. methyl alcohol dissolve 1.41 gms.  $\text{RbCl}$  at 25°. (Turner and Bissett, 1913.)

ethyl	"	"	0.078	gm.	"	"	"	"
propyl	"	"	0.015	"	"	"	"	"
amyl	"	"	0.0025	"	"	"	"	"

anhydrous hydrazine dissolve 5 gms.  $\text{RbCl}$  at room temp.

(Welsh and Brodersen, 1915.)

zing-point data (solubility, see footnote, p. 1) for  $\text{RbCl} + \text{AgCl}$  and  
+  $\text{TiCl}$  are given by Sandomnini (1911, 1914). Results for  $\text{RbCl} + \text{NaCl}$   
en by Zemcznzy and Rambach (1910).



# RUBIDIUM CHLORIDE

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## RUBIDIUM TELLURIUM CHLORIDE $\text{Rb}_2\text{TeCl}_4$ .

100 gms. aq. HCl of 1.2 Sp. Gr. dissolve 0.34 gm.  $\text{Rb}_2\text{TeCl}_4$  at  $23^\circ$ .  
 100 gms. aq. HCl of 1.05 Sp. Gr. dissolve 13.09 gms.  $\text{Rb}_2\text{TeCl}_4$  at  $23^\circ$ .  
 (Wheeler.)

## RUBIDIUM THALLIUM CHLORIDE $3\text{RbClTiCl}_3 \cdot 2\text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 13.3 gms. at  $18^\circ$ , and 62.5 gms. at  $100^\circ$ . (Godeffroy)

## RUBIDIUM CHROMATE (Mono) $\text{Rb}_2\text{CrO}_4$ .

SOLUBILITY IN WATER.  
 (Schreinmakers and Filippo, Jr., 1906.)

$t^\circ$ .	Gms. $\text{RbCrO}_4$ per 100 Gms. Solution.	$t^\circ$ .	Gms. $\text{RbCrO}_4$ per 100 Gms. Solution.	$t^\circ$ .	Gms. $\text{RbCrO}_4$ per 100 Gms. Solution.
-7	36.65	50	47.44	-2.40	15
0	38.27	60.4	48.90	-3.25	20
10	40.23	Solid Phase, Ice		-4.14	24
20	42.42	-0.6	0.95	-5.55	30
30	44.11	-1.1	7.22	-6.71	34
40	46.13	-1.57	9.87	about -7	36

## EQUILIBRIUM IN THE SYSTEM RUBIDIUM OXIDE, CHROMIUM TRIOXIDE WATER AT $30^\circ$ .

(Schreinmakers and Filippo, Jr., 1906.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid
$\text{CrO}_3$ .	$\text{Rb}_2\text{O}$ .		$\text{CrO}_3$ .	$\text{Rb}_2\text{O}$ .	
0	60.56	$\text{RbOH}$	13.91	3.38	$\text{Rb}_2\text{Cr}_2\text{O}_7$
0	56.82	$\text{Rb}_2\text{CrO}_4$	15.05	3.45	" + R
0.776	37.88	"	15.31	3.59	$\text{Rb}_2\text{O}$
2.80	34.89	"	15.19	3.19	$\text{Rb}_2\text{Cr}_2\text{O}_7$
4.96	30.20	"	18.96	2.37	"
8.54	28.17	"	24.92	1.66	"
11.98	27.99	"	37.34	1.61	"
15.38	28.73	"	48.20	1.54	"
15.54	28.55	" + $\text{Rb}_2\text{Cr}_2\text{O}_7$	53.87	1.67	"
13.69	23.87	$\text{Rb}_2\text{Cr}_2\text{O}_7$	54.29	1.28	" +
9.98	17.56	"	58.69	1.07	$\text{Rb}_2\text{C}$
5.72	8.47	"	62.38	0.93	"
4.58	7.98	"	62.74	0.93	"
4.87	4.60	"	63.07	0.92	"
8.16	3.57	"	62.28	0	"

## RUBIDIUM DICHROMATE $\text{Rb}_2\text{Cr}_2\text{O}_7$ .

SOLUBILITY OF THE POLYMORPHIC FORMS IN WATER  
 (Stortenbecker, 1907; see also Wyruboff, 1901.)

$t^\circ$ .	Gms. $\text{Rb}_2\text{Cr}_2\text{O}_7$ per 100 Gms. Sat. Sol.	
	Monoclinic Form.	Triclinic Form.
18	5.42	4.96
24	6.94	6.55
30	9.08	8.70
40	13.22	12.90
50	18.94	18.77
65	28.10	27.30

100 gms. sat. aq. solution contain 9.47 gms.  $\text{Rb}_2\text{Cr}_2\text{O}_7$ , at  $30^\circ$   
 (Schreinemaker)

## RUBIDIUM FLUORIDE $\text{RbF} \cdot 1\frac{1}{2}\text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 130.6 gms.  $\text{RbF}$  at  $18^\circ$ .



**HYDROXIDE**  $\text{RbOH}$ .

sat. aqueous solution contain 63.39 gms.  $\text{RbOH}$  at  $30^\circ$ .  
 (Schreinemakers and Filippo, 1906.)  
 sat. aqueous solution contain 64.17 gms.  $\text{RbOH}$  at  $15^\circ$ . (de Forcrand, 1909a.)  
 joint data for mixtures of  $\text{RbOH} + \text{NaOH}$  are given by (v. Hevesy,

**IODATE**  $\text{RbIO}_3$ .

$\text{H}_2\text{O}$  dissolve 2.1 gms.  $\text{RbIO}_3$  at  $23^\circ$ . (Wheeler, 1892.)

**PerIODATE**  $\text{RbIO}_4$ .

$\text{H}_2\text{O}$  dissolve 0.65 gm.  $\text{RbIO}_4$  at  $13^\circ$ ,  $d_{20}^4$  of sat. solution = 1.0052.  
 (Barker, 1908.)

**IODIDE**  $\text{RbI}$ .

$\text{H}_2\text{O}$  dissolve 137.5 gms.  $\text{RbI}$  at  $6.9^\circ$ , and 152 gms at  $17.4^\circ$ .  
 (Reissig, 1863.)

## SOLUBILITY OF RUBIDIUM IODIDE IN ORGANIC SOLVENTS.

(Walden, 1906.)

Solvent.	Formula.	Gms. $\text{RbI}$ per 100 cc. Solution.	
		at $0^\circ$	at $25^\circ$
acetonitrile	$\text{CH}_3\text{CN}$	1.478	1.350
acetonitrile	$\text{C}_2\text{H}_5\text{CN}$	0.274	0.305
dimethylmethane	$\text{CH}_3\text{NO}_2$	0.567	0.518
acetone	$(\text{CH}_3)_2\text{CO}$	0.960	0.674
acetic anhydride	$\text{C}_4\text{H}_6\text{O}_3$	...	4.930

joint data for  $\text{RbI} + \text{AgI}$  are given by Sandonnini (1912a).

**PerIODIDES**SOLUBILITY IN WATER AT  $25^\circ$ .

(Foote and Chalker, 1908.)

10 Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
		$\text{RbI}$ .	$\text{I}$ .	
0	$\text{RbI}$	28.01	64.85	$\text{RbI}_2 + \text{I}$
5.90	" + $\text{RbI}_2$	27.85	65.12	"
8.02	$\text{RbI}_2$	27.83	65.13	"
38.08	"	27.99	64.98	"

Its show that  $\text{RbI}$ , and  $\text{RbI}_2$  are not formed.

**BROMIODIDE**  $\text{RbBr}_2$ .

sat. aq. solution contain about 44 gms.  $\text{RbBr}_2$ , and the Sp. Gr. of solution is 3.84.  
 (Wells and Wheeler, 1892.)

**IRIDATE and IRIDITES**

## SOLUBILITIES IN WATER.

(Delépine, 1908.)

Salt.	Formula.	$t^\circ$ .	Gms. Salt per 100 Gms. $\text{H}_2\text{O}$ .
rubidium Chloroiridate	$\text{Rb}_2\text{IrCl}_6$	19	0.0555
rubidium Hexachloroiridite	$\text{Rb}_2\text{IrCl}_6 \cdot \text{H}_2\text{O}$	19	0.91
rubidium Aquopentachloroiridite	$\text{Rb}_2\text{IrCl}_5(\text{H}_2\text{O})$	19	1.05

**ParamOLYBDATE**  $5\text{Rb}_2\text{O} \cdot 12\text{MoO}_3 \cdot \text{H}_2\text{O}$ .

sat. aq. solution contain 1.941 gms. of the salt at  $24^\circ$ . (Wempe, 1912.)



# RUBIDIUM NITRATE

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## RUBIDIUM NITRATE $\text{RbNO}_3$

SOLUBILITY IN WATER.  
(Berkeley, 1904.)

t°.	Mols. $\text{RbNO}_3$ Per Liter.	Grams $\text{RbNO}_3$ per 100 Gms.		t°.	Mols. $\text{RbNO}_3$ Per Liter.	Gms. $\text{RbNO}_3$ per 100 Gms.	
		Water.	Solution.			Water.	Solution.
0	1.27	19.5	16.3	60	7.99	200	66.7
10	2.04	33.0	24.8	70	9.02	251	71.5
20	3.10	53.3	34.6	80	9.93	309	75.6
30	4.34	81.3	44.8	90	10.77	375	78.9
40	5.68	116.7	53.9	100	11.54	452	81.9
50	6.88	155.6	60.9	118.3	12.76	617	86.1

The following Sp. Gr. determinations are also given by Berkeley.

t°.	0.6	15.85	31.55	45.85	63.4	75.60	90.95	118.3°
Sp. Gr. Sat. Sol.	0.1389	1.2665	1.4483	1.6216	1.8006	1.9055	2.0178	2.1867

\* Boiling-point.

## THE SOLUBILITY AND SUPERSOLUBILITY ICE CURVES FOR RUBIDIUM NITRATE AND WATER. (Jones, 1908.)

t° of Cryst. of Ice.	Gms. $\text{RbNO}_3$ per 100 Gms. $\text{H}_2\text{O}$ .		t° of Cryst. of Ice.	Gms. $\text{RbNO}_3$ per 100 Gms. $\text{H}_2\text{O}$ .	
	Solubility Curve.	Supersolubility Curve.		Solubility Curve.	Supersolubility Curve.
-0.4	1.16	...	-3.5	...	9.94
-1.8	...	1.24	-2.3	13.97	...
-2.1	...	5.39	-4.2	...	13.97
-1.7	9.94	...	-2.7 Cryohydrate	17.11	...

## RUBIDIUM Telluric Acid OXALATE $\text{Rb}_2[\text{H}_6\text{TeO}_6\text{C}_2\text{O}_4]$

SOLUBILITY IN WATER.  
(Rosenheim and Weinheber, 1910-11.)

t°.	0°	20°	30°	40°	50°
Gms. $\text{Rb}_2[\text{H}_6\text{TeO}_6\text{C}_2\text{O}_4]$ per 100 gms. $\text{H}_2\text{O}$	3.85	7.26	9.40	12.76	16.90

## RUBIDIUM PERMANGANATE $\text{RbMnO}_4$

One liter of aqueous solution contains 6.03 gms.  $\text{RbMnO}_4$  at 7°.

100 cc. sat. aq. solution contain 0.46 gm.  $\text{RbMnO}_4$  at 2°, 1.06 gms. at 19°<sup>20</sup>  
4.68 gms. at 60°.

(Muthmann and Kuntze, 1894)  
(Patterson, 1895)

## RUBIDIUM SELENATE $\text{Rb}_2\text{SeO}_4$

100 gms.  $\text{H}_2\text{O}$  dissolve 158.9 gms.  $\text{Rb}_2\text{SeO}_4$  at 12°.

(Tutton, 1894)

## SOLUBILITY OF MIXED CRYSTALS OF RUBIDIUM ACID SELENATE AND RUBIDIUM ACID TELLURATE AND OF RUBIDIUM ACID SULFATE AND RUBIDIUM ACID TELLURATE IN WATER AT 25°.

(Pellini, 1909.)

Results for  $\text{RbHSO}_4 + \text{RbHTeO}_4$ .

Gms. per 1000 cc. Sat. Sol.		Mol. % Selenate
RbHSO <sub>4</sub> .	RbHTeO <sub>4</sub> .	in Solid Phase.
76.46	39.51	51.55
95.82	35.30	52.22
171.70	22.98	53.95
462.80	5	56.33
859.30	3.40	67.46

Results for  $\text{RbHSO}_4 + \text{RbHSeO}_4$ .

Gms. per 1000 cc. Sat. Sol.		Mol. % S
RbHSO <sub>4</sub>	RbHTeO <sub>4</sub>	in Solid P
26.675	38.403	47.9
32.117	31.58	50.
42.917	26.764	50.
59.074	20.182	50.
498.25	0.02887	52.

## RUBIDIUM FLUOSILICATE $\text{Rb}_2\text{SiF}_6$

100 gms.  $\text{H}_2\text{O}$  dissolve 0.16 gm.  $\text{Rb}_2\text{SiF}_6$  at 20°, and 1.36 gms. at 100°.

(Stolba, 1867)

## RUBIDIUM SILICOTUNGSTATE $\text{Rb}_8\text{SiW}_{12}\text{O}_{42}$

100 gms.  $\text{H}_2\text{O}$  dissolve 0.65 gm.  $\text{Rb}_8\text{SiW}_{12}\text{O}_{42}$  at 20°, and 5.1 gms. at 100°.

(Godfrey, 1876)



RUBIDIUM SULFATE  $\text{Rb}_2\text{SO}_4$ . SOLUBILITY IN WATER.

## SOLUBILITY IN WATER.

(Etard, 1894; Berkeley, 1904.)

Mols. $\text{Rb}_2\text{SO}_4$ per Liter.	Gms. $\text{Rb}_2\text{SO}_4$ per 100 Gms.		t°.	Mols. $\text{Rb}_2\text{SO}_4$ per Liter.	Gms. $\text{Rb}_2\text{SO}_4$ per 100 Gms.	
	Water.	Solution.			Water.	Solution.
1.27	36.4	27.3	60	2.15	67.4	40.3
1.46	42.6	29.9	70	2.25	71.4	41.7
1.64	48.2	32.5	80	2.34	75.0	42.9
1.79	53.5	34.9	90	2.42	78.7	44.0
1.92	58.5	36.9	100	2.49	81.8	45.0
2.04	63.1	38.7	102.4	2.50	82.6	45.2

Following Sp. Gr. determinations are also given by Berkeley.

	0.5	15.80	31.6	44.2	57.90	74.75	89.45	102.4*
Sp. Gr.	1.2740	1.3287	1.3704	1.3998	1.4232	1.4480	1.4649	1.4753

\* b. pt.

c. sat. solution in absolute  $\text{H}_2\text{SO}_4$  contain 58.81 gms.  $\text{Rb}_2\text{SO}_4$ .

(Bergius, 1910.)

## SOLUBILITY OF RUBIDIUM DOUBLE SULFATES IN WATER AT 25°

(Locke, 1902.)

Formula.	Per 100 cc. $\text{H}_2\text{O}$ .		Formula.	Per 100 cc. $\text{H}_2\text{O}$ .	
	Gms. Anh. Salt.	Mols. Salt.		Gms. Anh. Salt.	Mols. Salt.
$\text{SO}_4)_2, 6\text{H}_2\text{O}$	76.7	0.1615	$\text{Rb}_2\text{Mn}(\text{SO}_4)_2, 6\text{H}_2\text{O}$	35.7	0.0857
$\text{SO}_4)_2, 6\text{H}_2\text{O}$	9.28	0.022	$\text{Rb}_2\text{Mg}(\text{SO}_4)_2, 6\text{H}_2\text{O}$	20.2	0.0521
$\text{SO}_4)_2, 6\text{H}_2\text{O}$	10.28	0.0241	$\text{Rb}_2\text{Ni}(\text{SO}_4)_2, 6\text{H}_2\text{O}$	5.98	0.0142
$\text{SO}_4)_2, 6\text{H}_2\text{O}$	24.28	0.0579	$\text{Rb}_2\text{Zn}(\text{SO}_4)_2, 6\text{H}_2\text{O}$	10.10	0.0236

RUBIDIUM Dihydroxy TARTARIC ACID  $\text{Rb}_2\text{C}_4\text{H}_4\text{O}_8, 3\text{H}_2\text{O}$ .gms.  $\text{H}_2\text{O}$  dissolve 6.51 gms.  $\text{Rb}_2\text{C}_4\text{H}_4\text{O}_8, 3\text{H}_2\text{O}$  at 0°.

(Fenton, 1898.)

account of the unstable character of the compound, only  $\frac{1}{2}$  hour was allowed for the solution.

## RUBIDIUM SALTS

## SOLUBILITIES IN WATER.

(Howe, 1894.)

Salt.	Formula.	t°.	Gms. Salt per 100 Gms. $\text{H}_2\text{O}$ .
Ammonium Potassium Nitrososulfate	$\text{K}_2\text{RuCl}_5\text{NO}$	25	12
"	"	60	80
Ammonium Nitrososulfate	$(\text{NH}_4)_2\text{RuCl}_5\text{NO}$	25	5
"	"	60	22
Rubidium Nitrososulfate	$\text{Rb}_2\text{RuCl}_5\text{NO}$	25	0.57
"	"	60	2.13
" (hydrated)	$\text{Rb}_2\text{RuCl}_5\text{NO} \cdot 2\text{H}_2\text{O}$	25	114.3
Caesium Nitrososulfate	$\text{Cs}_2\text{RuCl}_5\text{NO}$	25	0.20
"	"	60	0.56
" (hydrated)	$\text{Cs}_2\text{RuCl}_5\text{NO} \cdot 2\text{H}_2\text{O}$	25	105.8

RUBIDIUM (1, Benzosulfonazole, 2(1), one)  $\text{C}_6\text{H}_4 < \begin{smallmatrix} \text{SO}_2 \\ \text{CO} \end{smallmatrix} > \text{NH}$ .gms.  $\text{H}_2\text{O}$  dissolve 0.4 part at 25° and 4.17 parts at 100°.

gms. alcohol dissolve 4 parts at 25°.

(U. S. P. VIII.)

gms. trichlorethylene dissolve 0.012 gm. saccharin at 15°.

(Wester and Bruins, 1914.)



## DISTRIBUTION OF SACCHARIN AT 25° BETWEEN:

Water \* and Ether.  
(Marden, 1914.)Water † and Amyl A  
(Marden, 1914.)

Gms. Saccharin per:		Dist. Coef.	Gms. Saccharin per:	
100 cc. H <sub>2</sub> O Layer.	50 cc. Ether Layer.		105 cc. Aq. Layer.	50 cc. Amyl Acetate Layer.
0.0290	0.0438	0.267	0.0045	0.0700
0.0458	0.0829	0.235	0.0065	0.0957
0.0719	0.1245	0.245	0.0114	0.1724

\* Slightly acidified with HCl.

† Containing 5 cc. conc. HCl per 100 cc

The amount of saccharin entering the ethereal layer is increased of HCl to the aqueous layer. With 5 cc. conc. HCl per 100 cc. H<sub>2</sub>O, the distribution coefficient is reduced to 0.0624.

**SALICIN** C<sub>6</sub>H<sub>4</sub>(CH<sub>2</sub>.OH)O.C<sub>6</sub>H<sub>11</sub>O<sub>6</sub>.

## SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. per 100 Gms. Solvent.	Author
Water	15	3.52	(Greenish and
Water	25	4.16	(Dott, 1907.)
90% Alcohol	15	1.5	(Greenish and
90% Alcohol	15	2	(Squire and C
Trichlor Ethylene	15	0.013	(Wester and B

**SALICYLAMIDE** OH.C<sub>6</sub>H<sub>4</sub>CONH<sub>2</sub>.DISTRIBUTION BETWEEN WATER AND OLIVE OIL.  
(Meyer, 1901.)

t°.	Gms. OHC <sub>6</sub> H <sub>4</sub> CONH <sub>2</sub> per 100 cc.		Dist. Co
	H <sub>2</sub> O Layer.	Oil Layer.	
3	0.056	0.126	2.25
36	0.075	0.107	1.40

**SALICYLIC ACID** C<sub>6</sub>H<sub>4</sub>.OH.COOH 1:2.

## SOLUBILITY IN WATER.

(Average curve from the closely agreeing determinations of Walker and Wood, 1898; a 1905; at 25°, Paul, 1894; at 20°, Hoitsema, 1898a; Hoffman and Langbeck, 1905. For not in good agreement with the following, see Alexejew, 1886; Bourgoin, 1878; Ost., 1878

t°.	Gms. C <sub>6</sub> H <sub>4</sub> .OH.COOH per Liter Solution.	t°.	Gms. C <sub>6</sub> H <sub>4</sub> .OH.COOH per Liter Solution.	t°.	C <sub>6</sub> H <sub>4</sub> . Lite
0	0.8	25	2.2	60	
10	1.2	30	2.7	70	
20	1.8	40	3.7	80	
		50	5.4		

SOLUBILITY OF SALICYLIC ACID IN WATER  
(Savorro, 1914.)

t°.	Gms. C <sub>6</sub> H <sub>4</sub> .OH.COOH per 1000 Gms. Sat. Sol.	t°.	Gms. C <sub>6</sub> H <sub>4</sub> .OH.COOH per 1000 Gms. Sat. Sol.	t°.	C <sub>6</sub> H <sub>4</sub> . per %
0	1.24	35	3.51	70	1
5	1.29	40	4.16	75	1
10	1.35	45	4.80	80	2
15	1.84	50	6.38	85	2
20	2	55	7.44	90	3
25	2.48	60	9	95	5
30	2.98	65	10.94	100	7



## SOLUBILITY OF SALICYLIC ACID (LIQUID) IN WATER.

terminations by Synthetic Method. See Note, p. 16. The original data in this case were plotted and the following figures read from the curves.

(Alexejew.)			(Flaschner and Rankin, 1910.)		
Gms. $C_6H_4OHCOOH$ per 100 Gms.		t°.	Gms. $C_6H_4OHCOOH$ per 100 Gms.		
Aqueous Layer.	Salicylic Acid Layer.		Aqueous Layer.	Salicylic Acid Layer.	
7	68	60	4.5	68	
8	64	70	6.5	62.5	
12	58	80	10	54	
19	49	85	15	46	

crit. temp. 32 87 crit. temp. 30

for the melting-point curve of mixtures of solid salicylic acid and water as given by Flaschner and Rankin.

## SOLUBILITY OF SALICYLIC ACID IN AQUEOUS SALT SOLUTIONS AT 25° AND AT 35°.

Normality of Salt Solution.	Gms. Salt per Liter.	$C_6H_4OH.COOH$ Dissolved at 25°.		$C_6H_4OH.COOH$ Dissolved at 35°.	
		Gms. per 1000 Gms. Sat. Sol.	Gm. Mol. Per cent.	Gms. per 1000 Gms. Sat. Sol.	Gm. Mol. Per cent.
0.020	1.49	2.24	$2.9216 \cdot 10^{-4}$	3.23	$4.2206 \cdot 10^{-4}$
0.100	7.46	2.25	2.9377 "	3.23	4.2203 "
0.492	36.73	2.02	2.6321 "	3.01	3.9268 "
1.004	74.92	1.89	2.4759 "	2.68	3.5003 "
0.020	2.02	2.25	3.9351 "	3.25	4.2499 "
0.100	10.12	2.30	3.0103 "	3.32	4.3334 "
0.504	51.10	2.38	3.1061 "	3.38	4.4123 "
1.004	101.60	2.39	3.1249 "	3.36	4.3848 "
0.020	1.19	2.23	2.9110 "	3.22	4.2062 "
0.100	5.95	2.22	2.9027 "	3.20	4.1806 "
0.497	29.50	2	2.6128 "	2.85	3.7171 "
0.988	58.80	1.72	2.2487 "	2.43	3.1596 "

## SOLUBILITY OF SALICYLIC ACID IN AQUEOUS SALT SOLUTIONS AT 25°.

(Philip, 1905; Philip and Garner, 1909.)

In Aq. Sodium Acetate.		In Aq. Sodium Formate.		In Aq. Sodium Monochloracetate.	
Gms. per Liter.		Gms. per Liter.		Gms. per Liter.	
$Na_2C_2H_3O_2$	$C_6H_4OHCOOH$	$HCOONa$	$C_6H_4OHCOOH$	$CH_2ClCOONa$	$C_6H_4OHCOOH$
1	3.60	0.81	3.40	1.38	2.83
8	5.93	1.63	4.42	3.43	3.58
13	9.56	4.06	7.11	6.84	4.64
17	16.81	8.14	10.44	13.71	6.17
In Aq. Sodium Succinate.		In Aq. Potassium Formate.		In Aq. Sodium Butyrate at 26.4°.	
Gms. per Liter.		Gms. per Liter.		Gms. per Liter.	
$Na_2C_4H_4O_6$	$C_6H_4OHCOOH$	$HCOOK$	$C_6H_4OHCOOH$	$C_4H_7COONa$	$C_6H_4OHCOOH$
18	2.97	0	2.265	1	3.3
23	4.34	1.03	3.38	2	4.5
35	6.56	2.56	4.93	4	6.85
73	10.82	5.12	7.13	5	8.1

liter of 1 normal aqueous sodium salicylate solution dissolves 4.97 gms. salicylic acid at 25°.

(Sidgwick, 1910.)



# ALICYCLIC ACID

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## SOLUBILITY OF SALICYLIC ACID IN AQUEOUS SOLUTIONS OF SALICYLATE AT 20.1°.

(Hoitsema, 1898a.)

Gm. Mols. per Liter.		Sp. Gr. of Solutions.	Gms. per Liter.		Solid
$C_6H_5OH-COOH.$	$C_6H_5OH-COONa.$		$C_6H_5OH-COOH.$	$C_6H_5OH-COONa.$	
0.0132	0	1.002	1.823	0	$C_6H_5O$
0.0112	0.017	1.003	1.55	2.705	
0.0124	0.113	1.009	1.71	17.98	
0.0143	0.226	1.016	1.97	35.96	
0.0164	0.344	1.024	2.26	54.74	
0.0203	0.500	1.034	2.80	79.56	
0.062	1.70	1.112	8.56	270.5	
0.095	2.11	1.137	13.11	335.7	$C_6H_5OHCOOH$ + $C_6H_5OHC$
0.091	2.19	1.144	12.56	348.4	$C_6H_5OHCOOH$
0.086	3.41	1.215	11.88	542.6	
0.081	4.23	1.263	11.19	673	$C_6H_5OHCOOH$ + $C_6H_5OHC$
0.048	4.18	1.259	6.63	665.1	$C_6H_5O$
0.021	4.12	1.258	2.90	665.5	
0.	4.15	1.257	0	660.3	

## SOLUBILITY OF SALICYLIC ACID IN AQUEOUS SOLUTIONS OF ACID

(Kendall, 1911.)

Acid.	Gms. per Liter.		Acid.	Gms.	
	Acid.	$C_6H_5OH-COOH.$		Acid.	
Water alone	0	2.257	Formic Acid	230.15	H
Acetic Acid	37.52 $CH_3COOH$	2.335	"	460.30	
"	75.05 "	2.409	Hydrochloric Acid	0.653	
"	150.10 "	2.549	"	1.302	
"	300.20 "	2.850	"	4.558	
Formic Acid	2.38 $HCOOH$	2.114	"	9.117	
"	4.59 "	2.035	"	18.235	
"	11.05 "	2.114	Malonic Acid	3.253	CE
"	21.17 "	2.035	"	10.49	
"	28.76 "	2.049	"	20.84	
"	57.53 "	2.066	Methyl Picric Acid	2.28	
"	115.07 "	2.121			

## SOLUBILITY OF SALICYLIC ACID IN AQUEOUS SOLUTIONS OF ACID AT 25° AND VICE VERSA.

(Kendall, 1911.)

Gms. per Liter.		Solid Phase.	Gms. per Liter.	
$C_6H_5NO_2-COOH.$	$C_6H_5OHCOOH.$		$C_6H_5NO_2-COOH.$	$C_6H_5OHCOOH.$
0	2.257	Salicylic Acid	7.188	2.243
2.615	1.974	"	7.213	1.877
7.202	1.887	"	7.233	1.29
7.283	1.885	" + Nitrobenzoic		

## SOLUBILITY OF SALICYLIC ACID IN AQUEOUS ALC

(Seidell, 1908, 1909, 1910.)

Wt. Per cent $C_6H_5OH$ in Solvent.	$d_{20}$ Sat. Sol.	Gms. $C_6H_5OHCOOH$ per 100 Gms. Sat. Sol.	Wt. Per cent $C_6H_5OH$ in Solvent.	$d_{20}$
10	0.984	0.38	60	
20	0.970	0.80	70	
30	0.959	2.20	80	
40	0.951	5.90	90	
50	0.945	12.20	100	



ITY OF SALICYLIC ACID IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL, AL ALCOHOL, DEXTROSE, CANE SUGAR, AND OF LEVULOSE AT 25°  
35°.

(Hoffmann and Langbeck, 1905.)

amt.	Conc. of Solvent.		C <sub>6</sub> H <sub>5</sub> OH.COOH Dissolved at 25°.		C <sub>6</sub> H <sub>5</sub> OH.COOH Dissolved at 35°.	
	Normal- ity.	Gms. per Liter.	Gm. Mol. Per cent.	Gms. per 100 Gms. Sat. Sol.	Gm. Mol. Per cent.	Gms. per 100 Gms. Sat. Sol.
	0.0249	1.146	2.8966 · 10 <sup>-4</sup>	0.222	4.2044 · 10 <sup>-4</sup>	0.322
	0.0560	2.578	2.9150 "	0.223	4.2348 "	0.324
	0.1747	8.04	2.9901 "	0.229	...	...
	0.2399	11.05	...	...	4.4341 "	0.339
	1.03	47.4	3.5279 "	0.270	5.2816 "	0.404
	1.638	75.44	3.9253 "	0.300	...	...
(iso)	0.020	1.496	2.909 "	0.223	4.229 "	0.324
	0.051	3.74	2.955 "	0.226	4.289 "	0.329
	0.100	7.48	3.033 "	0.232	4.435 "	0.339
	0.521	38.60	3.718 "	0.285	5.024 "	0.431
	0.02	3.6	2.886 "	0.221	4.184 "	0.321
	0.10	18	2.898 "	0.222	4.202 "	0.322
	0.50	89.6	2.954 "	0.226	4.263 "	0.326
	1	180	3.015 "	0.231	4.360 "	0.334
	0.02	6.88	2.902 "	0.221	4.206 "	0.322
	0.10	34.97	2.964 "	0.227	4.287 "	0.328
	0.50	172	3.239 "	0.248	4.697 "	0.360
	1.10	376.3	3.633 "	0.278	5.236 "	0.401
	0.02	3.6	2.888 "	0.221	...	...
	0.06	10.8	2.895 "	0.221	...	...
	0.25	45	2.944 "	0.225	...	...

LITY OF SALICYLIC ACID IN ALCOHOLS, IN ETHER AND IN ACETONE.

(Timofeiew, 1891; at 15°, Bourgoïn, 1878; at 23°, Walker and Wood, 1898.)

amt.	t°.	Gms. C <sub>6</sub> H <sub>5</sub> OHCOOH per 100 Gms.		Solvent.	t°.	Gms. C <sub>6</sub> H <sub>5</sub> OHCOOH per 100 Gms.	
		Solvent.	Solution.			Solvent.	Solution.
	- 3	40.67	28.91	C <sub>2</sub> H <sub>5</sub> OH(n)	- 3	26.12	20.71
	+ 21	62.48	38.46	C <sub>2</sub> H <sub>5</sub> OH(n)	+ 21	37.69	27.36
	- 3	36.12	26.29	(CH <sub>3</sub> ) <sub>2</sub> O	15	50.47	33.55
	+ 15	49.63	33.17	(CH <sub>3</sub> ) <sub>2</sub> O	17	...	23.4*
	21	53.53	34.87	(CH <sub>3</sub> ) <sub>2</sub> CO	23	...	31.3*
90%	15	42.09	29.62				

\* Gms. per 100 cc. sat. sol. instead of per 100 gms. sat. sol.

is. sat. solution in methyl alcohol contain 39.87 gms. salicylic acid at 15°.  
(Savorro, 1914.)

ITY OF SALICYLIC ACID IN MIXTURES OF ACETONE AND BENZENE AT 25°.

(Marden and Dover, 1917.)

Gms. Mixed Solvent. ne. Salicylic Acid.	Gms. per 100 Gms. Mixed Solvent.		Gms. per 100 Gms. Mixed Solvent.	
	Acetone.	Salicylic Acid.	Acetone.	Salicylic Acid.
55	60	36.7	20	15
51.1	50	31	10	7.1
46.4	40	25.3	0	0.92
42.3	30	20		



## SOLUBILITY OF SALICYLIC ACID IN BENZENE.

(Walker and Wood, 1898.)

(von Euler and Löwenham, 1916.)

t°.	Gms. $C_6H_5OHCOOH$ per 100 Gms. $C_6H_6$ .	t°.	Gms. $C_6H_5OHCOOH$ per 100 Gms. $C_6H_6$ .	t°.	Solvent.	Gms. $C_6H_5OHCOOH$ per 100 cc. Sat. Sol.
11.7	0.460	34.6	1.261	18	$C_6H_6$	0.525
18.2	0.579	36.6	1.430	25	$C_6H_6$	0.762
25	0.78	49.4	2.380	18	0.5% $CH_2ClCOOH$ in $C_6H_6$	1.698
30.5	0.991	64.2	4.40	18	0.5% $C_6H_5OH$ in $C_6H_6$	0.746

## SOLUBILITY OF SALICYLIC ACID IN MIXTURES OF BENZENE AND ETHYL ACETATE AT 25°.

(Marden and Dover, 1917.)

Gms. per 100 Gms. Mixed Solvent.	Gms. per 100 Gms. Mixed Solvent.	Gms. per 100 Gms. Mixed Solvent.
Ethyl Acetate. Salicylic Acid.	Ethyl Acetate. Salicylic Acid.	Ethyl Acetate. Salicylic Acid.
100 38	60 16.6	20 6.2
90 24.2	50 14.5	10 3.42
80 22.7	40 12.8	0 0.92
70 19.5	30 9.6	

## SOLUBILITY OF SALICYLIC ACID IN SEVERAL SOLVENTS AT 25°.

(Herz and Rathmann, 1913.)

Solvent.	Gms. $C_6H_5OHCOOH$ per 100 cc. Sat. Sol.	Solvent.	Gms. $C_6H_5OH$ per 100 cc. Sat. Sol.
Chloroform	2.168	Tetrachlor Ethylene	1.10
Carbon Tetrachloride	0.4143	Tetrachlor Ethane	2.08
Trichlor Ethylene	1.519	Pentachlor Ethane	1.064

100 gms. dichlor ethylene dissolve 0.757 gm. salicylic acid at 15°. }  
 100 gms. trichlor ethylene dissolve 0.28 gm. salicylic acid at 15°. } (West-  
 Bruins,

## SOLUBILITY OF SALICYLIC ACID IN OILS (Temp. not stated).

(Engfeldt, 1913.)

Oil of:	Gms. $C_6H_5OHCOOH$ per 100 Gms. Sat. Sol.	Oil of:	Gms. $C_6H_5OH$ per 100 cc. Sat. Sol.
Phocæ (Dog Fish Oil)	1.70	Sesami	2.65
Jecoris Aselli (Cod Liver Oil)	1.86	Cannabis	3
Arachidis (Peanut Oil)	1.88	Lini (Linseed Oil)	3.02
Amygdalarum	2.08	Juglandis (Walnut Oil)	3.12
Olivæ (Olive Oil)	2.14	Gossypii (Cottonseed Oil)	3.22
Rapæ (Rape Seed Oil)	2.17	Ricini (Castor Oil)	12.92
Papaveris (Poppy Seed Oil)	2.22	Paraffiniam Liquid	0

The ratio of the solubilities of salicylic acid in olive oil and in water (conc. in oil ÷ conc. in  $H_2O$ ) at 25° is given as 11.8 by Boeseken and Waterman (1912). This corresponds to 2.6 gms. acid per 100 gms. olive oil.

## DISTRIBUTION OF SALICYLIC ACID BETWEEN:

Water and Benzene. (Hendrixon, 1897.)

Water and Chloroform. (Hendrixon, 1897.)

Results at 10°.		Results at 40°.		Results at 10°.		Results at 40°.	
Gms. Acid 100 cc.	Gms. Acid per 100 cc.	Gms. Acid 100 cc.	Gms. Acid per 100 cc.	Gms. Acid 100 cc.	Gms. Acid per 100 cc.	Gms. Acid 100 cc.	Gms. Acid per 100 cc.
$H_2O$ Layer.	$C_6H_6$ Layer.	$H_2O$ Layer.	$C_6H_6$ Layer.	$H_2O$ Layer.	$CHCl_3$ Layer.	$H_2O$ Layer.	$CHCl_3$ Layer.
0.0264	0.0391	0.0260	0.0400	0.0293	0.0442	0.0335	0.044
0.0377	0.0655	0.0719	0.1640	0.0457	0.0946	0.0819	0.17
0.1200	0.4159	0.1220	0.3539	0.1172	0.5640	0.1589	0.52
0.1292	0.4713	0.1563	0.5016	0.1220	0.6196	0.2687	1.38
		0.2014	0.7625	0.1236	0.6269	0.3053	1.75

Similar data for the distribution between water and benzene at 18° are given by Nernst (1891).



**SALICYLIC ACID** (Aspirin)  $\text{CH}_3\text{COO.C}_6\text{H}_4.\text{COOH}$ , 1.2.

FREEZING AND MELTING-POINT CURVES FOR MIXTURES OF ACETYL SALICYLIC ACID AND WATER, DETERMINED BY THE SYNTHETIC METHOD.  
(Flaschner and Rankin, 1909.)

Solubility Curve (Liquid Acid + $\text{H}_2\text{O}$ ).		M.-pt. Curve (Solid Acid + $\text{H}_2\text{O}$ ).	
Gms. $\text{CH}_3\text{COO.C}_6\text{H}_4.\text{COOH}$ per 100 Gms.		t°.	Gms. $\text{CH}_3\text{COO.C}_6\text{H}_4.\text{COOH}$ per 100 Gms. Mixture.
H <sub>2</sub> O Rich Layer.	Acid Rich Layer.		
4.8	...	82.4	4.8
6	74	90.4	10
10	67	92.4	20
14	60	93.6	60
17.5	55	99	80
20	50	109.4	89.5
lit. temp.	35	131	100

**Phenylsalicylate**  $\text{C}_6\text{H}_4.\text{OH.COOC}_6\text{H}_5$ , 1.2.

SOLUBILITY OF SALOL IN AQUEOUS ALCOHOL AT 25°. (Seidell, 1909, 1910.)

d <sub>20</sub> of Sat. Sol.	Gms. Salol per 100 Gms. Sat. Sol.	Wt. Per cent $\text{C}_6\text{H}_5\text{OH}$ in Solvent.	d <sub>20</sub> of Sat. Sol.	Gms. Salol per 100 Gms. Sat. Sol.
0.999	0.015	70	0.877	4.40
0.967	0.020	80	0.863	7.70
0.934	0.22	90	0.865	14
0.914	0.76	92.3	0.868	17.70
0.895	2.10	100	0.898	35

SOLUBILITY OF SALOL IN SEVERAL SOLVENTS. (Seidell, 1907.)

t°.	d Sat. Sol.	Gms. Salol per 100 Gms. Sat. Sol.	Solvent.	t°.	d Sat. Sol.	Gms. Salol per 100 Gms. Sat. Sol.
30-31	...	90.99	Amyl Alcohol	25	0.869	20.44
30-31	1.148	88.57	Acetic Acid (99.5%)	21.5	1.143	63.24
ate 30-31	1.136	85.29	Xylene	32.5	...	87.14+
30-31	...	very soluble	Toluene	25	1.128	83.62

Salol is readily dissolved by 381 gms. salol at 20°-25° (Dehn, 1917). The solution separates into two layers.

FREEZING TEMPERATURES (Solubility, see footnote, p. 1) FOR MIXTURES OF: Salol and Thymol. (Bellucci, 1912.) Salol and Urethan. (Bellucci, 1912, 1913.)

Gms. Salol per 100 Gms. Mixture.	t° of Solidif.	Gms. Salol per 100 Gms. Mixture.	t° of Solidif.	Gms. Salol per 100 Gms. Mixture.	t° of Solidif.	Gms. Salol per 100 Gms. Mixture.
100	23	50	42	100	36.5	50
90	29	40	36.5	90	39	40
80	34.5	30	29 Eutec.	86	41.5	30
70	40	20	31	80	44	20
66	46	10	30	70	47	10
60	51	0	34	60	48.5	0

Freezing point for salol + camphor is at +6° and contains 56% salol. (Bellucci, 1912.) Freezing point for salol + monobromcamphor is at 21° and contains 60% salol. (Bellucci, 1912, 1913.) Freezing temperatures for Salol + Sulfonal and for Salol +  $\beta$  Naphthol by Bianchini (1914).

**IN  $\text{C}_{12}\text{H}_{18}\text{O}_2$ .**

SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. $\text{C}_{12}\text{H}_{18}\text{O}_2$ per 100 Gms. Solvent.	Authority.
...	20-25	0.02+	(Dehn, 1917.)
al (90%)	15	about 2.3	(Greenish and Smith, 1903.)
lor Ethylene	15	2.46	(Wester and Bruins, 1914.)
ine	20-25	12.72	(Dehn, 1917.)
50% Pyridine	20-25	12.35	"

Freezing data for mixtures of stereoisomeric santonin salts are given by Malvino (1908).



**SAMARIUM CHLORIDE**

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**SAMARIUM CHLORIDE**  $\text{SaCl}_3$ .100 gms. pyridine dissolve 6.38 gms.  $\text{SaCl}_3$  at  $15^\circ$ .

(Matignon, 1906, 1909.)

**SAMARIUM GLYCOLATE**  $\text{Sa}(\text{C}_2\text{H}_5\text{O}_2)_2$ .100 gms.  $\text{H}_2\text{O}$  dissolve 0.6373 gm.  $\text{Sa}(\text{C}_2\text{H}_5\text{O}_2)_2$  at  $20^\circ$ .

(Jantsch and Grünkraut, 1912-13.)

**SAMARIUM Double NITRATES.**SOLUBILITY IN CONC.  $\text{HNO}_3$  OF  $d_{15} = 1.325$  AT  $16^\circ$ .

(Jantsch, 1912.)

Salt.	Formula.	Gms. Hydrated Salt per 100 cc. Sat. Sol.
Samarium Magnesium Nitrate	$[\text{Sa}(\text{NO}_3)_6]\text{Mg}_3 \cdot 24 \text{H}_2\text{O}$	24.55
" Nickel	" $\text{Ni}_3$ "	29.11
" Cobalt	" $\text{Co}_3$ "	34.27
" Zinc	" $\text{Zn}_3$ "	36.47
" Manganese	" $\text{Mn}_3$ "	50.04

**SAMARIUM OXALATE**  $\text{Sa}_2(\text{C}_2\text{O}_4)_3 \cdot 10\text{H}_2\text{O}$ .One liter  $\text{H}_2\text{O}$  dissolves 0.00054 gm.  $\text{Sa}_2(\text{C}_2\text{O}_4)_3$  at  $25^\circ$ , determined by the electrolytic conductivity method. (Rimbach and Schubert, 1909.)**SOLUBILITY OF SAMARIUM OXALATE IN AQUEOUS SOLUTIONS OF SULFURIC**AT  $25^\circ$ .

(Wirth, 1912.)

Normality of Aq. $\text{H}_2\text{SO}_4$ .	Gm. $\text{Sa}_2(\text{C}_2\text{O}_4)_3$ per 100 Gms. Sat. Sol.	Solid Phase.	Normality of Aq. $\text{H}_2\text{SO}_4$ .	Gm. $\text{Sa}_2(\text{C}_2\text{O}_4)_3$ per 100 Gms. Sat. Sol.	Solid Phase.
1	0.1015	$\text{Sa}_2(\text{C}_2\text{O}_4)_3 \cdot 10\text{H}_2\text{O}$	2.8	0.3886	$\text{Sa}_2(\text{C}_2\text{O}_4)_3 \cdot 10\text{H}_2\text{O}$
1.445	0.1804	"	4.32	0.7008	"
1.93	0.2254	"	6.175	1.072	"

**SAMARIUM Dimethyl PHOSPHATE**  $\text{Sa}_2[(\text{CH}_3)_2\text{PO}_4]_3$ .100 gms.  $\text{H}_2\text{O}$  dissolve 35.2 gms.  $\text{Sa}_2[(\text{CH}_3)_2\text{PO}_4]_3$  at  $25^\circ$  and about 10.8 gr at  $95^\circ$ .

(Morgan and James, 19)

**SAMARIUM SULFATE**  $\text{Sa}_2(\text{SO}_4)_3$ .SOLUBILITY IN AQUEOUS SOLUTIONS OF AMMONIUM SULFATE AT  $25^\circ$ .\*

(Keyes and James, 1914.)

Gms. per 100 Gms. $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	Solid Phase.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	Solid Phase.
$(\text{NH}_4)_2\text{SO}_4$ .	$\text{Sa}_2(\text{SO}_4)_3$ .		$(\text{NH}_4)_2\text{SO}_4$ .	$\text{Sa}_2(\text{SO}_4)_3$ .	
0.03	2.1	$\text{Sa}_2(\text{SO}_4)_3$	32.5	0.9	1.1.7
0.8	2	"	46.3	1	"
1.1	2.8	" + 1.1.7	77.5	1.3	" + $(\text{NH}_4)_2\text{SO}_4$
1.9	1.5	1.1.7	77.3	0.3	$(\text{NH}_4)_2\text{SO}_4$
7.4	0.8	"	76.8	0.6	"
18.8	0.8	"			

1.1.7 =  $\text{Sa}_2(\text{SO}_4)_3 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 7\text{H}_2\text{O}$ .SOLUBILITY IN AQUEOUS SOLUTIONS OF SODIUM SULFATE AT  $25^\circ$ .\*

(Keyes and James, 1914.)

Gms. per 100 Gms. $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	Solid Phase.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	Solid Phase.
$\text{Na}_2\text{SO}_4$ .	$\text{Sa}_2(\text{SO}_4)_3$ .		$\text{Na}_2\text{SO}_4$ .	$\text{Sa}_2(\text{SO}_4)_3$ .	
...	2.05	$\text{Sa}_2(\text{SO}_4)_3$	10.51	0.012	$2\text{Sa}_2(\text{SO}_4)_3 \cdot 3\text{Na}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$
0.1	2	"	14.71	0.010	"
0.5	0.11	$2\text{Sa}_2(\text{SO}_4)_3 \cdot 3\text{Na}_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$	20.02	0.012	"
1.9	0.03	"	23.68	0.018	"
6.44	0.016	"	27.40	0.011	"

\* The mixtures were rotated at constant temperature for 5 months.

100 cc. anhydrous hydrazine dissolve 1 gm.  $\text{Sa}_2(\text{SO}_4)_3$  at room temp.

(Welsh and Broderston, 191)



## IUM SULFONATES

## SOLUBILITY IN WATER.

Salt.	Formula.	g.	Gm. Anhydrous Salt per 100 Gms. H <sub>2</sub> O.	Authority.
n $\pi$ Nitro-				
e Sulfonate	$\text{Sa}[\text{C}_6\text{H}_4(\text{NO}_2)\text{SO}_3]_2 \cdot 7\text{H}_2\text{O}$	15	50.9	(Holmberg, 1907.)
n Bromonitro-				
e Sulphonate	$\text{Sa}[\text{C}_6\text{H}_3(\text{Br})(\text{NO}_2)\text{SO}_3]_2 \cdot 10\text{H}_2\text{O}$	25	7.84	(Katz and James, 1913.)

IUM OXALATE  $\text{Sc}_2(\text{C}_2\text{O}_4)_3 \cdot 5\text{H}_2\text{O}$ .

## ITY IN AQUEOUS SOLUTIONS OF AMMONIUM OXALATE AND OF HYDROCHLORIC ACID.

Aq. Ammonia Oxalate at 25°.		In Aq. Hydrochloric Acid at 25° and at 50°.		
(Wirth, 1914.)		(Meyer, 1914.)		
per 100 Gms. Sat. Sol.	Solid Phase.	Normality of Aq. HCl.	Gms. $\text{Sc}_2(\text{C}_2\text{O}_4)_3$ per 100 Gms. Sat. Sol.	
			At 25°.	At 50°.
0.3019	$\text{Sc}_2(\text{C}_2\text{O}_4)_3 \cdot 5\text{H}_2\text{O}$	0.1	0.0299	0.0420
0.4012	"	0.5	0.0650	0.0870
0.7108	" $+(\text{NH}_4)_2\text{C}_2\text{O}_4$	1	0.1020	0.1435
		2	0.1716	0.2556
		5	0.4170	0.6533

## SOLUBILITY IN AQUEOUS SOLUTIONS OF SULFURIC ACID.

Results at 25°.		Results at 25° and at 50°.		
(Wirth, 1914.)		(Meyer, 1914.)		
of Gms. $\text{Sc}_2(\text{C}_2\text{O}_4)_3$ per 100 Gms. Sat. Sol.	Solid Phase.	Normality of Aq. $\text{H}_2\text{SO}_4$ .	Gms. $\text{Sc}_2(\text{C}_2\text{O}_4)_3$ per 100 Gms. Sat. Sol.	
			At 25°.	At 50°.
0.1148	$\text{Sc}_2(\text{C}_2\text{O}_4)_3 \cdot 5\text{H}_2\text{O}$	0.1	0.0385	0.0562
0.2573	"	0.5	0.0997	0.1481
0.2904	"	1	0.1663	0.2493
0.4204	"	2	0.3176	0.4429
0.5834	"	5	0.7761	1.1280

ms. sat. solution of scandium oxalate in 2.43  $\pi$   $\text{H}_2\text{SO}_4$  + 0.5  $\pi$  oxalic acid contain 0.0284 gm.  $\text{Sc}_2\text{O}_3$  at 25°.

(Wirth, 1914.)

IUM SULFATE  $\text{Sc}_2(\text{SO}_4)_3 \cdot 5\text{H}_2\text{O}$ .

## ITY IN WATER AND IN AQUEOUS SULFURIC ACID AT 25°.

(Wirth, 1914.)

g.	Gms. $\text{Sc}_2(\text{SO}_4)_3$ per 100 Gms. Sat. Sol.	Solid Phase.	Solvent.	Gms. $\text{Sc}_2(\text{SO}_4)_3$ per 100 Gms. Sat. Sol.	Solid Phase.
	28.52	$\text{Sc}_2(\text{SO}_4)_3 \cdot 5\text{H}_2\text{O}$	4.86 $\pi$ $\text{H}_2\text{SO}_4$	8.363	$\text{Sc}_2(\text{SO}_4)_3 \cdot 5\text{H}_2\text{O}$
$\text{SO}_4$	29.29	"	9.73 $\pi$ $\text{H}_2\text{SO}_4$	1.315	"
$\text{SO}_4$	19.87	"	22.35 $\pi$ $\text{H}_2\text{SO}_4$	0.484	$\text{Sc}_2(\text{SO}_4)_3 \cdot 3\text{H}_2\text{O}$

limum sulfuric acid double sulfate,  $\text{Sc}_2(\text{SO}_4)_3 \cdot 3\text{H}_2\text{SO}_4$ . 100 gms. sat. sol. in  $\text{SO}_4$  of  $d = 1.6$  contain 0.8616 gm. of the double salt.

(Wirth, 1914.)

IC ACID  $(\text{CH}_2)_8(\text{COOH})_2$ .

ms. 95% formic acid dissolves 1.05 gm. sebacic acid at 19°.

(Aschan, 1913.)

## ISTRIBUTION OF SEBACIC ACID BETWEEN WATER AND ETHER AT 25°.

(Chandler, 1908.)

Mol. Concentration of Sebacic Acid in:		Ratio.
Aq. Layer.	Ether Layer.	
0.00062	0.0291	0.0213
0.00058	0.0272	0.0213
0.00047	0.0213	0.0221
0.00036	0.0155	0.0232



## SELENIUM Se.

## SOLUBILITY IN CARBON DISULFIDE.

(Marc, 1906.)

100 cc.  $\text{CS}_2$  dissolve 0.065 gm. amorphous Se at room temperature. Se which is heated to  $180^\circ$  for 6-7 hours is insoluble in  $\text{CS}_2$ . Se crystallized from the melt at  $200^\circ$  is insoluble in  $\text{CS}_2$ . Se heated once quickly to  $140^\circ$  is very slightly soluble in  $\text{CS}_2$ .

100 cc.  $\text{CS}_2$  dissolve at the boiling-point 3-3.4 mgs. Se which has been heated to  $140^\circ$  for 1 hr.

100 cc.  $\text{CS}_2$  dissolve at the boiling-point 2 mgs. Se which has been heated to  $195^\circ$  for 2 days. (Marc, 1907.)

100 gms. methylene iodide ( $\text{CH}_2\text{I}_2$ ) dissolve 1.3 gms. Se at  $12^\circ$ . (Retgers, 1895.)

SOLUBILITY OF MIX CRYSTALS OF SELENIUM AND SULFUR IN CARBON DISULFIDE AT  $25^\circ$ . (Ringer, 1902.)

Mols. per 100 Mols. Solution.			Mol. Per Cent Se in Crystals.	Mols. per 100 Mols. Solution.			Mol. Per Cent Se in Crystals.
$\text{CS}_2$ .	Se.	S.		$\text{CS}_2$ .	Se.	S.	
43.1	0	56.9	0	58.24	2.35	39.41	55.67
45.1	0.93	53.97	3.54	64.66	1.58	33.76	68.38
44.98	1.03	53.99	3.81	81.11	2.4	16.49	58.7
47.84	2.07	50.59	8.69	88.41	2.17	9.42	61.5
49.54	2.19	48.27	16.4*	91.38	1.68	6.94	65
47.62	2.16	50.22	14.2*	99.51	0.49	0	100†
46.12	1.485	52.39	29.35*	99.14	0.86	0	100‡

\* Mix crystals homogeneous in all except these solutions.

† = Solubility of hexagonal selenium.

‡ = Solubility of amorphous selenium.

Fusion-point curves for mixtures of selenium and other metals are given by Pelabon (1909). Results for Se + Te are given by Pellini and Vio (1906).

Diphenyl SELENIUM BROMIDE  $(\text{C}_6\text{H}_5)_2\text{SeBr}_2$ .RECIPROCAL SOLUBILITY OF DIPHENYL SELENIUM BROMIDE AND DIPHENYL TELLURIUM BROMIDE IN WATER AT  $25^\circ$ .

(Pellini, 1906a.)

Gms. per 1000 cc. Sat. Sol.		Mol. % $(\text{C}_6\text{H}_5)_2\text{SeBr}_2$ in Cryst. Mixture.	Gms. per 1000 cc. Sat. Sol.		Mol. % $(\text{C}_6\text{H}_5)_2\text{TeBr}_2$ in Cryst. Mixture.
$(\text{C}_6\text{H}_5)_2\text{TeBr}_2$ .	$(\text{C}_6\text{H}_5)_2\text{SeBr}_2$ .		$(\text{C}_6\text{H}_5)_2\text{TeBr}_2$ .	$(\text{C}_6\text{H}_5)_2\text{SeBr}_2$ .	
18.614	0	0	10.224	14.608	44.
17.400	1.448	4.91	7.544	19.876	51.
16.152	4.172	10.51	6.780	18.984	94.
15.030	6.210	18.21	3.184	17.392	95.8.
13.320	8.148	24.98	0	18.984	100
11.940	11.420	34.94			

SELENIC ACID  $\text{H}_2\text{SeO}_4$ 

## SOLUBILITY IN WATER, DETERMINED BY FREEZING-POINT METHOD.

(Kremann and Hofmeier, 1908.)

t°.	Gms. $\text{H}_2\text{SeO}_4$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{H}_2\text{SeO}_4$ per 100 Gms. Sat. Sol.	Solid Phase.
0	0	Ice	-55	71.5	$\text{H}_2\text{SeO}_4 \cdot 4\text{H}_2\text{O}$
-10	21	"	-65 Eutec.	74	" + $\text{H}_2\text{SeO}_4$
-20	30	"	-50	75.5	$\text{H}_2\text{SeO}_4 \cdot \text{H}_2\text{O}$
-30	36	"	-20	79	"
-40	40	"	0	81	"
-50	42.5	"	+20	85	"
-60	45	"	26 m. pt.	88	"
-80	48	"	20	91	"
-95 Eutec.	50	" + $\text{H}_2\text{SeO}_4 \cdot 4\text{H}_2\text{O}$	16 Eutec.	91.5	" + $\text{H}_2\text{SeO}_4$
-80	52	$\text{H}_2\text{SeO}_4 \cdot 4\text{H}_2\text{O}$	30	93	$\text{H}_2\text{SeO}_4$
-70	54	"	40	94.5	"
-60	58	"	50	96.5	"
-51 m. pt.	67	"	60	100	"



**SLENIOUS ACID**  $\text{H}_2\text{SeO}_3$ .

## SOLUBILITY IN WATER.

(Etard, 1894.)

t°.	Gms. $\text{H}_2\text{SeO}_3$ per 100 Gms. Solution.	t°.	Gms. $\text{H}_2\text{SeO}_3$ per 100 Gms. Solution.	t°.	Gms. $\text{H}_2\text{SeO}_3$ per 100 Gms. Solution.
-10	42.2	25	67	60	79.3
0	47.4	30	70.2	70	79.3
-10	55	40	77.5	80	79.3
20	62.5	50	79.2	90	79.4

**SLENIOUS ANHYDRIDE** (Selenium Dioxide)  $\text{SeO}_2$ .

## SOLUBILITY IN SEVERAL SOLVENTS.

(de Coninck, 1906.)

Solvent.	t°.	Gms. $\text{SeO}_2$ per 100 cc. Solvent.
Water	11.3-15	38.5
Ethyl Alcohol (93%)	14.1	10.2
Methyl Alcohol	11.8	6.66
Acetone	15.3	4.35
Acetic Acid (Glacial)	12.9	1.11

**CA**  $\text{SiO}_2$ .

## SOLUBILITY IN WATER AND IN AQUEOUS SOLUTIONS OF ACIDS.

(Lenher and Merrill, 1917.)

platinum bottle and stirrer were used. The silica was prepared by adding 1 tetrachloride to water. The gel thus formed was washed until free of and dried between filter papers. Conductivity water was used and equilibrium was reached within 24 hours. The saturated solution was evaporated in a platinum dish. The residue was weighed and the silica volatilized with  $\text{HF} + \text{H}_2\text{SO}_4$ . The difference was considered to show "the amount of silica which had changed from an unfilterable to a filterable state of division."

Results for Aq. $\text{HCl}$ :			Results for Aq. $\text{H}_2\text{SO}_4$ :		
At 25°.			At 90°.		
Cent.	Gm. $\text{SiO}_2$ per 50 cc. Sol.	Per cent $\text{HCl}$	Gm. $\text{SiO}_2$ per 50 cc. Sol.	Per cent $\text{H}_2\text{SO}_4$	Gm. $\text{SiO}_2$ per 50 cc. Sol.
1	0.0080	0	0.0213	3.9	0.0211
	0.00665	2	0.0198	7.3	0.0186
3	0.00465	3	0.0186	15.6	0.0112
1	0.00245	5.4	0.0152	25.4	0.0058
9	0.0008	7.6	0.0115	36	0.0034
1	0.0006	10	0.0091	46.9	0.0013
6	0.0003	13.6	0.0056	55.6	0.0005
		18.6	0.0029	71	0.0004

0°, a slow current of  $\text{CO}_2$  through the solutions did not affect the results. Silica reaches equilibrium very slowly as compared with silica gel. The solubility of ignited silica is probably the same as that of gelatinous silica.

## SOLUBILITY OF SILICA IN MELTED CALCIUM CHLORIDE.

(Arndt and Lowenstein, 1909.)

t°.	Gms. $\text{SiO}_2$ per 100 Gms. Sat. Solution.
800	2.5
850	3.8
900	5.4
950	7.6



SOLUBILITY IN LEAD, IN ZINC AND IN SILVER.  
(Moissan and Siemens, 1904.)

In Lead.		In Zinc.		In Silver.	
t°.	Gm. Si per 100 Gms. Lead.	t°.	Gm. Si per 100 Gms. Zinc.	t°.	Gm. Si per 100 Gms. Silver.
1250	0.024	600	0.06	970	9.22 (58.02)
1330	0.070	650	0.15	1150	14.89 (27.66)
1400	0.150	730	0.57	1250	19.26 (19)
1450	0.210	800	0.92	1470	41.46 (16)
1550	0.780	850	1.62		

The silicon which crystallized from the saturated solution in silver was found to be incompletely soluble in HF. The figures in parentheses show percentage soluble in HF in each case.

Freezing-point data for mixtures of silicon tetraphenyl and tin tetra- are given by Pascal (1912).

**SILICON IODIDES**  $\text{Si}_2\text{I}_6$ ,  $\text{SiI}_4$ .

SOLUBILITY IN CARBON DISULFIDE.  
(Friedel and Lachburg, 1869; Friedel, 1869.)

100 gms.  $\text{CS}_2$  dissolve 19 gms.  $\text{Si}_2\text{I}_6$  at 19°.  
100 gms.  $\text{CS}_2$  dissolve 26 gms.  $\text{Si}_2\text{I}_6$  at 27°.  
100 gms.  $\text{CS}_2$  dissolve 2.2 gms.  $\text{SiI}_4$  at 27°.

**SILICO TUNGSTIC ACID**  $\text{H}_2\text{SiW}_{12}\text{O}_{40}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 961.5 crystallized silico tungstic acid at 18°, and solution has Sp. Gr. 2.843.

**SILVER** Ag.

For equilibrium between metallic Silver and mercury (Silver amalgam) in mixed aqueous solutions of their nitrates, determined for mixtures of the metals in all proportions, see Reinders, 1906.

**SILVER ACETATE**  $\text{CH}_3\text{COOAg}$ .

SOLUBILITY IN WATER.

(Nernst, 1889; Arrhenius, 1893; Goldschmidt, 1898; Nauman and Rucker, 1905; Raupenstrauch, 1885; Wright and Thompson, 1884, 1885.)

t°.	Gms. Ag(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) per Liter.	t°.	Gms. Ag(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) per Liter.	t°.	Gms. Ag(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) per Liter.
0	7.22	25	11.2	50	16.4
10	8.75	30	12.1	60	18.9
15	9.4	40	14.1	70	21.8
20	10.4			80	25.2

SOLUBILITY OF SILVER ACETATE IN AQUEOUS SOLUTIONS OF:

Silver Nitrate.			Sodium Acetate.		
Gms. AgNO <sub>3</sub> per Liter.	Gms. CH <sub>3</sub> COOAg per Liter at:		Gms. CH <sub>3</sub> COONa per Liter.	Gms. CH <sub>3</sub> COOHg per Liter at:	
	16° (Nernst).	19.8° (Arrhenius).		16° (N., N. and R.).	18.6° (A.).
0	10.05	9.85	0	10.05	9.9
5	8.2	7.9	5	6.3	6.6
10	7.0	6.6	10	4.6	4.9
15	6.4	5.5	15	3.8	4.1
20	5.7	4.5	20	3.3	3.5
30	4.4	...	30	...	2.8
40	3.2	...	40	...	2.4



## SOLUBILITY OF SILVER ACETATE IN AQUEOUS SALT SOLUTIONS AT 25°. (Jaques, 1920.)

Solution of;	Gms. Salt. per Liter.	Gms. AgC <sub>2</sub> H <sub>3</sub> O <sub>2</sub> per Liter.	Aq. Solution of:	Gms. Salt per Liter.	Gms. AgC <sub>2</sub> H <sub>3</sub> O <sub>2</sub> per Liter.
alone	0	11.08	Potassium Acetate	2.22	9.60
um Acetate	1.15	10.39	" "	22.2	4.43
"	5.76	8.10	" "	111	2.41
"	11.52	6.71	" "	222	2.18
"	57.6	4.33	Silver Nitrate	2.77	9.93
"	115.2	3.95	" "	5.55	9
Acetate	1.63	10.69	" "	11.10	7.41
"	8.13	9.45	" "	22.21	5.81
"	16.26	8.34	Sodium Acetate	1.97	9.27
"	81.3	7.26	" "	19.7	4.21
"	162.6	5.99	" "	98.5	2.33
			" "	197	2.07

## SOLUBILITY OF SILVER ACETATE IN AQUEOUS SOLUTIONS OF NITRIC ACID AT 25°. (Hill and Simmons, 1909.)

Normality of Aq. HNO <sub>3</sub> .	Per cent HNO <sub>3</sub> in Solvent.	d <sub>20</sub> of Sat. Sol.	Gms. AgC <sub>2</sub> H <sub>3</sub> O <sub>2</sub> per Liter Sat. Sol.
0	0	1.005	11.13
0.50	3.096	1.072	85.31
1	6.128	1.140	161.9
2	11.757	1.267	307.4
4.02	22.386	1.470	549.3
5.03	27.328	1.561	656
6.44	33.813	1.670	792.2

These are also given for the solubility of AgC<sub>2</sub>H<sub>3</sub>O<sub>2</sub> + AgNO<sub>3</sub> in Aq. HNO<sub>3</sub> at 25°.

## SOLUBILITY OF SILVER ACETATE IN AQUEOUS SOLUTIONS OF SEVERAL COMPOUNDS AT 25°. (Armstrong and Eyre, 1913.)

Aqueous solution of:	Gms. Compound per 1000 Gms. H <sub>2</sub> O.	Gms. AgC <sub>2</sub> H <sub>3</sub> O <sub>2</sub> per 1000 Gms. Sat. Sol.	Aqueous Solution of:	Gms. Compound per 1000 Gms. H <sub>2</sub> O.	Gms. AgC <sub>2</sub> H <sub>3</sub> O <sub>2</sub> per 1000 Gms. Sat. Sol.
Water	0	11.08	Propyl Alcohol	15	9.88
Aldehyde	11	10.13	" "	60	8.03
Aldehyde	11	8.92	Glycerol	9.21	8.66
"	33	9.16	Glycol	15.5	10.86
ethyl Alcohol	66.4	7.55	"	62.1	8.44

SOLUBILITY OF MONOCHLORACETATE CH<sub>3</sub>ClCOOAg.

Its aqueous solution contains 12.97 gms. CH<sub>3</sub>ClCOOAg at 16.9°. (Arrhenius, '93.)

## SOLUBILITY OF SILVER MONO CHLOR ACETATE AT 16.9° IN AQUEOUS SOLUTIONS OF:

Silver Nitrate.		Sodium Chlor Acetate.	
Gms. AgNO <sub>3</sub> per Liter.	Gms. CH <sub>3</sub> ClCOOAg per Liter.	Gms. CH <sub>3</sub> ClCOONa per Liter.	Gms. CH <sub>3</sub> ClCOOAg per Liter.
0.0	12.97	0.0	12.97
9.6	10.05	3.88	10.05
17.0	7.55	7.77	8.16
		15.53	6.02
		31.07	4.19
		58.26	3.26



# SILVER ACETATE

600

## SOLUBILITY OF SILVER MONOCHLORO ACETATE IN NITRIC ACID AT 25° (Hill and Simmons, 1909.)

Normality of Ag. HNO <sub>3</sub> .	Gms. HNO <sub>3</sub> per 100 Gms. Solvent.	d <sub>20</sub> of Sat. Sol.	Gms. AgC <sub>2</sub> H <sub>3</sub> ClO <sub>2</sub> per Liter.
0	0	1.0095	15.18
0.25	1.564	1.0426	50.33
0.50	3.096	1.0791	91.83
1	6.128	1.1473	167.3
2	11.757	1.2716	310.8
4	22.277	1.4749	549.1
5	27.185	1.5673	659.2

## SILVER Dipropyl ACETATE AgC<sub>6</sub>H<sub>13</sub>O<sub>2</sub>.

100 gms. H<sub>2</sub>O dissolve 0.123 gm. AgC<sub>6</sub>H<sub>13</sub>O<sub>2</sub> at 11.7°, and 0.190 gm. at 25°; (Fiedler, 1891.)

## SILVER Methyl Ethyl ACETATE Ag.CH<sub>3</sub>.CH<sub>2</sub>.CH(CH<sub>3</sub>).COO.

## SILVER Diethyl ACETATE Ag[(C<sub>2</sub>H<sub>5</sub>)<sub>2</sub>CH.COO].

## SILVER Trimethyl ACETATE Ag(CH<sub>3</sub>)<sub>3</sub>CCOO.\*

### SOLUBILITY OF EACH IN WATER. (Sedlitzky, 1887; Keppiah, 1888; Stiassny, 1891.)

t°.	Gms. per 100 Gms. H <sub>2</sub> O.			t°.	Gms. per 100 Gms. H <sub>2</sub> O.		
	Ag.C <sub>3</sub> H <sub>7</sub> O <sub>2</sub> .	AgC <sub>4</sub> H <sub>9</sub> O <sub>2</sub> .	AgC <sub>5</sub> H <sub>11</sub> O <sub>2</sub> .*		AgC <sub>3</sub> H <sub>7</sub> O <sub>2</sub> .	AgC <sub>4</sub> H <sub>9</sub> O <sub>2</sub> .	AgC <sub>5</sub> H <sub>11</sub> O <sub>2</sub> .*
0	1.112	0.402	1.10	50	1.602	0.536	1.41
10	1.126	0.413	1.15	60	1.827	0.585	1.57
20	1.182	0.432	1.22	70	2.093	0.643	1.68
30	1.280	0.458	1.22	80	2.402	...	1.80
40	1.420	0.494	1.37				

## SILVER ARSENATE Ag<sub>3</sub>AsO<sub>4</sub>.

One liter H<sub>2</sub>O dissolves 0.0085 gm. Ag<sub>3</sub>AsO<sub>4</sub> at 20°. See Note, p. 608. (Whitby, 1910)

## SILVER ARSENITE Ag<sub>3</sub>AsO<sub>3</sub>.

One liter H<sub>2</sub>O dissolves 0.0115 gm. Ag<sub>3</sub>AsO<sub>3</sub> at 20°. See Note, p. 608. (Whitby, 1910)

## SILVER BENZOATE C<sub>6</sub>H<sub>5</sub>COOAg.

One liter of aqueous solution contains 1.763 gms. C<sub>6</sub>H<sub>5</sub>COOAg at 14.5°, and 2.607 gms. at 25°. (Holleman, 1893; Noyes and Schwarz, 1898.)

### SOLUBILITY OF SILVER BENZOATE AT 25° IN AQUEOUS SOLUTIONS OF:

#### Nitric Acid (N. and S.).

#### Chloracetic Acid (N. and S.).

Gms. Mols. per Liter.		Gms. per Liter.		Gms. Mols. per Liter.		Gms. per Liter.	
HNO <sub>3</sub> .	C <sub>6</sub> H <sub>5</sub> COOAg.	HNO <sub>3</sub> .	C <sub>6</sub> H <sub>5</sub> COOAg.	CH <sub>3</sub> ClCOOH.	C <sub>6</sub> H <sub>5</sub> COOAg.	CH <sub>3</sub> ClCOOH.	C <sub>6</sub> H <sub>5</sub> COOAg.
0	0.01144	0	2.607	0	0.01144	0	2.607
0.004435	0.01395	0.280	3.195	0.00394	0.01385	0.371	3.172
0.00887	0.01698	0.559	3.889	0.00787	0.01612	0.744	3.691
0.00892	0.01715	0.562	3.926	0.01574	0.02093	1.487	4.792
0.01774	0.02324	1.118	5.321				
0.02674	0.03071	1.686	7.031				

One liter of cold alcohol dissolves 0.169 gm. C<sub>6</sub>H<sub>5</sub>COOAg; one liter of boiling alcohol dissolves 0.465 gm. (Liebermann, 1902.)

## SILVER BORATE AgBO<sub>3</sub>.

One liter of aqueous solution contains about 9.05 gms. AgBO<sub>3</sub> at 25°. (Abegg and Cox, 1904.)



**SILVER BROMATE**  $\text{AgBrO}_3$ .

## SOLUBILITY IN WATER.

t°.	Gms. $\text{AgBrO}_3$ per Liter.	Authority.
20	1.586	(Böttger, 1903.)
24.5	1.911	(Noyes, 1900.)
25	1.68	(Longi, 1883.)
27	1.71	(Whitby, 1910, see note, p. 608.)
25	1.949	(Hill, 1917.)

SOLUBILITY OF SILVER BROMATE IN AQUEOUS ACETIC ACID AT 25°.  
(Hill, 1917.)

Normality of Aq. Acetic Acid.	Gms. $\text{AgBrO}_3$ per Liter.	Normality of Aq. Acetic Acid.	Gms. $\text{AgBrO}_3$ per Liter.
0.0408	1.9429	0.4988	1.863
0.0997	1.9379	0.9975	1.8013
0.1995	1.9206	1.8721	1.6178

SOLUBILITY OF SILVER BROMATE IN AQUEOUS AMMONIA AND NITRIC ACID SOLUTIONS AT 25°.  
(Longi, 1883.)

	Solvent.	Gms. $\text{AgBrO}_3$ per	
		1000 cc. Sol.	1000 Gms. Sol.
Ammonia	Sp. Gr. 0.998 = 5%	35.10	35.54
Ammonia	Sp. Gr. 0.96 = 10%	443.6	462.5
Nitric Acid	Sp. Gr. 1.21 = 35%	3.81	3.12

## SOLUBILITY OF SILVER BROMATE AT 24.5° IN AQUEOUS SOLUTIONS OF:

## Silver Nitrate (Noyes).

## Potassium Bromate (N.).

Content.		Gms. per Liter.		Normal Content.		Gms. per Liter.	
$\text{AgBrO}_3$ .	$\text{AgNO}_3$ .	$\text{AgBrO}_3$ .		$\text{KBrO}_3$ .	$\text{AgBrO}_3$ .	$\text{KBrO}_3$ .	$\text{AgBrO}_3$ .
0.0081	0.0	1.911		0.0	0.0081	0.0	1.911
0.0051	1.445	1.203		0.0085	0.00519	1.42	1.225
0.0022	5.882	0.510		0.0346	0.00227	5.78	0.536

**SILVER BROMIDE**  $\text{AgBr}$ .

## SOLUBILITY IN WATER.

t°.	Gms. $\text{AgBr}$ per Liter.	Authority.
20	0.000084	(Böttger — Z. physik. Ch. 46, 602, '03.)
25	0.000137	(Abegg and Cox — Z. physik. Ch. 46, 11, '03.)
100	0.00370	(Böttger — Z. physik. Ch. 56, 93, '06.)

(See also Holleman — Z. physik. Ch. 12, 129, '93; Kohlrausch — *Ibid.* 50, 365, '05.)

SOLUBILITY OF SILVER BROMIDE IN AQUEOUS AMMONIA SOLUTIONS.  
p — Gazz. chim. ital. 13, 87, '83; at 80°, Pohl — Sitzber. Akad. Wiss. Wien, 41, 267, '60.)

Solvent.	Sp. Gr.	Gms. $\text{AgBr}$ at 12° per 1000 cc. Solvent.		Gms. $\text{AgBr}$ at 80° per 1000 Gms. Solvent.
		1000 cc. Solvent.	1000 Gms. Solvent.	
Ammonia	Sp. Gr. 0.998 = 5%	0.114	0.114	...
Ammonia	Sp. Gr. 0.96 = 10%	3.33-4.0	3.47	...
Ammonia	Sp. Gr. 0.986	...	...	0.51* 1.0†

\* Dried  $\text{AgBr}$ . † Freshly pptd.



## SOLUBILITY OF SILVER BROMIDE IN AQUEOUS AMMONIA SOLUTIONS.

d <sub>420</sub> of Sat. Sol.	Results at 15°. (Bodländer, 1892.)		Results at 25°. (Bodländer and Fittig, 1901-02.)		Results at 25°. (Whitney and Melcher, 1903.)	
	Gms. Mols. per Liter.		Gms. Mols. per 1000 Gms. H <sub>2</sub> O.		Concentration per Liter.	
	NH <sub>3</sub> .	AgBr.	NH <sub>3</sub> .	AgBr.	G. Mols. NH <sub>3</sub> .	G. Atoms Ag.
0.9932	1.085	0.0011	0.1932	0.00060	0.0764	0.000270
0.9853	2.365	0.0031	0.3849	0.00120	0.115	0.000391
0.9793	3.410	0.0050	0.7573	0.00223	0.268	0.000941
0.9720	4.590	0.0074	1.965	0.00692	0.273	0.00107
0.9655	5.725	0.0101	3.024	0.01163	0.450	0.00170
			5.244	0.02443	0.497	0.00159

## SOLUBILITY OF SILVER BROMIDE IN AQUEOUS SOLUTIONS OF:

Ammonia at 0°.

(Jarry, 1899.)

Monomethyl Amine at 11°.

(Jarry.)

Grams per 100 cc. Solution.				Gms. per 100 cc. Solution.	
NH <sub>3</sub> Gas.	AgBr.	NH <sub>3</sub> Gas.	AgBr.	NH <sub>3</sub> CH <sub>3</sub> .	AgBr.
3.07	0.080	26.27	1.067	11.01	0.07
4.88	0.096	31.26	1.568	13.17	0.12
6.69	0.172	33.89	1.987	15.13	0.16
8.29	0.212	36.52	2.669	17.97	0.28
11.51	0.349	37.22	2.888	32.58	0.55
15.32	0.557	37.70	2.930	35.62	0.73
18.09	0.722	39.26	2.892	43.11	1.27
19.53	0.741	39.95	2.852	48.44	2.89

## SOLUBILITY OF SILVER BROMIDE IN AQUEOUS SOLUTIONS OF METHYL AMINE AND OF ETHYL AMINE AT 25°.

(Bodländer and Eberlein, 1903; Wuth, 1902.)

In Methyl Amine.

Mols. per Liter.

In Ethyl Amine.

Mols. per Liter.

Total Base.	AgBr.	Free Base.*	Total Base.	AgBr.	Free Base.*
1.017	0.0025	1.012 (B. & E.)	0.483	0.00231	0.478 (B. & E.)
0.508	0.0013	0.505 (B. & E.)	0.200	0.00097	0.198 "
0.203	0.00049	0.202 (B. & E., W.)	0.100	0.000475	0.099 "
0.102	0.00026	0.102 (B. & E.)	0.103	0.000711	... (W.)
0.0947	0.00041	... (W.)	0.06572	0.000258	... "
0.051	0.00012	0.051 (B. & E.)	0.05512	0.000193	... "
0.04	0.00034	... (W.)	0.03942	0.000137	... "
0.02	0.00026	... (W.)	0.01272	0.0000867	... "

\* The free base is found by subtracting from the total base two mols. of base for each atom of dissolved

## SOLUBILITY OF SILVER BROMIDE IN AQUEOUS SOLUTIONS OF MERCURIC NITRATE AT 25°.

(Morse, 1902.)

Mols. HgNO <sub>3</sub> (HNO <sub>3</sub> ) per Liter.	Mols. AgBr per Liter.	Gms. AgBr per Liter.	Mols. HgNO <sub>3</sub> (HNO <sub>3</sub> ) per Liter.	Mols. AgBr per Liter.	Gms. Ag per Liter.
1	0.03660	6.878	0.025	0.00459	0.86
0.10	0.00873	1.640	0.0125	0.00329	0.6
0.05	0.00639	1.200	0.0100	0.00306	0.5

Since HNO<sub>3</sub> was present in all cases, its influence on the solubility was amined. It was found that no appreciable differences were obtained with concentrations varying between 0.1 and 2 normal HNO<sub>3</sub>. Both crystallized and amorphous silver bromide gave identical results.



SOLUBILITY OF SILVER BROMIDE IN AQUEOUS SALT SOLUTIONS.  
(Mees and Piper, 1912.)

Aqueous Solution.	g°.	Gms. AgBr per Liter.
Aq. 1 per cent Sodium Thiosulfate	?	2.06
" " Ammonium Thiocyanate	"	0.03
" " Ammonium Carbonate	"	0.004
" " Sodium Sulfate	"	0.055
" " Thiocarbamide	"	1.49

SOLUBILITY OF SILVER BROMIDE IN AQUEOUS SALT SOLUTIONS.  
(Valenta, 1894; see also Cohn, 1895.)

Salt Solution.	g°.	Gms. AgBr per 100 Gms. Aq. Solution of Concentration:				
		1:100.	5:100.	10:100.	15:100.	20:100.
n Thio Sulphate	20	0.35	1.90	3.50	4.20	5.80
" Calc. by Cohn	20	0.50	2.40	4.59	6.58	8.40
n Sulphite	25	...	...	0.04	...	0.08
ium Cyanide	25	...	6.55	...	...	...
" Calc. by Cohn	25	...	6.85	...	...	...
ium Sulphocyanide	25	...	...	0.73	...	...
mium Sulphocyanide	20	...	0.21	2.04	5.30	...
m Sulphocyanide	25	...	...	0.53	...	...
n Sulphocyanide	25	...	...	0.35	...	...
num Sulphocyanide	25	...	...	4.50	...	...
Carbamide	25	...	...	1.87	...	...
Cyanime	25	0.08	0.35	0.72	...	...

E. — Cohn shows that the lower results obtained by Valenta are due to the use of solid AgBr used and the consequent formation of the less soluble di salt,  $(\text{AgS}_2\text{O}_3\text{Na})_2\text{Na}_2\text{S}_2\text{O}_3$ , instead of the more soluble tri salt,  $(\text{AgS}_2\text{O}_3\text{Na})_3\text{Na}_2\text{S}_2\text{O}_3$ .

cc.  $\text{H}_2\text{O}$  containing 10 per cent of normal mercuric acetate,  $\text{Hg}(\text{C}_2\text{H}_3\text{O}_2)_2 +$  dissolve 0.0122 gm. AgBr at 20°.

gms. NaCl in conc. aq. solution dissolve 0.474 gm. AgBr at 15°.

gms. NaCl in 21 per cent solution dissolve 0.182 gm. AgBr at 15°.

gms. KBr in conc. solution dissolve 3.019 gms. AgBr at 15°.

mas. NaCl + 10 gms. KBr in conc. aq. solution dissolve 0.075 gm. AgBr  
(Schierholz, 1890.)

SOLUBILITY OF SILVER BROMIDE IN AQUEOUS POTASSIUM BROMIDE AT 25°.  
(Hellwig, 1900.)

1. KBr per Liter	2.76	3.68	4.18	4.44	4.864
2. KBr per Liter	2.20	7.50	13.50	17.95	26.44

SOLUBILITY OF SILVER BROMIDE IN AQUEOUS SOLUTIONS OF SODIUM SULFITE.

Results at Room Temperature (?).

(Mees and Piper, 1912.)

Gms. per Liter.		Gms. per Liter.	
D.	AgBr.	$\text{Na}_2\text{SO}_3$ .	AgBr.
8	0.000746	4.85	0.0329
7	0.00219	9.47	0.05264
6	0.00393	17.65	0.116
5	0.00448	38.2	0.265
3	0.00865	70.75	0.57
8	0.01585	83.75	0.79

Results at 25°.

(Luther and Leubner, 1912a.)

Gms. Formula Weights per Liter.	
$\text{SO}_3''$ .	Ag'.
0.232	0.0025
0.406	0.0023
0.448	0.0023
0.466	0.0053
0.474	0.0055
0.675	0.0084



# SILVER BROMIDE

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## SOLUBILITY OF SILVER BROMIDE IN AQUEOUS SOLUTIONS OF SODIUM THIOSULFATE AT 35°.

(Richards and Faber, 1899.)

Gms. Cryst. Na Thiosulfate per Liter.	Gms. AgBr Dissolved per Gm. of Thiosulphate.	Mols. AgBr Dissolved per Mol. of $\text{Na}_2\text{S}_2\text{O}_3$ .
100	0.376	0.496
200	0.390	0.515
300	0.397	0.524
400	0.427	0.564

100 cc. of 3 *n*  $\text{AgNO}_3$  solution dissolve 0.04 gm. AgBr at 25°. (Hel

Fusion-point data for mixtures of AgBr + AgCl and AgBr + AgI are Mönkemeyer (1906). Results for AgBr + NaBr are given by Sandon Scarpa (1913).

# SILVER BUTYRATE $\text{C}_4\text{H}_7\text{COOAg}$ .

## SILVER (Iso)BUTYRATE $(\text{CH}_3)_2\text{CHCOOAg}$ .

### SOLUBILITY OF EACH SEPARATELY IN WATER.

(Goldschmidt, 1898; Arrhenius, 1893; Raupenstrauch, 1885.)

t°.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .		t°.	Gms. per 100 Gms. H.	
	Butyrate.	Iso Butyrate.		Butyrate.	Iso Buty
0	0.363	0.796	30	0.561	1.060 (I
10	0.419	0.874	40	0.647	1.176 (I
17.8	0.432 (A.)	...	50	0.742	1.313
18.8	0.445 (A.)	...	60	0.848	...
20	0.484	0.961 (0.9986)	70	0.964	1.670
25	...	... (1.0442)	80	1.14	1.898

### SOLUBILITY OF SILVER BUTYRATE IN AQUEOUS SOLUTIONS OF SILVER ACETATE, SILVER NITRATE AND OF SODIUM BUTYRATE.

(Arrhenius, 1893.)

#### In Silver Acetate at 17.8°.

G. Mols. per Liter.		Grams per Liter.	
$\text{CH}_3\text{COOAg}$ .	$\text{C}_4\text{H}_7\text{COOAg}$ .	$\text{CH}_3\text{COOAg}$ .	$\text{C}_4\text{H}_7\text{COOAg}$ .
0.0	0.0221	0.0	4.32
0.0270	0.0139	4.51	2.71
0.0506	0.0103	8.45	2.01

#### In Silver Nitrate at 18.8

G. Mols. per Liter.		Grams per	
$\text{AgNO}_3$ .	$\text{C}_4\text{H}_7\text{COOAg}$ .	$\text{AgNO}_3$ .	C
0.0	0.0228	0.0	4
0.0667	0.0078	11.33	I
0.100	0.0062	17.00	I

#### In Sodium Butyrate at 18.2°.

G. Mols. per Liter.		Grams per Liter.		G. Mols. per Liter.		Grams per	
$\text{C}_4\text{H}_7\text{COONa}$ .	$\text{C}_4\text{H}_7\text{COOAg}$ .	$\text{C}_4\text{H}_7\text{COONa}$ .	$\text{C}_4\text{H}_7\text{COOAg}$ .	$\text{C}_4\text{H}_7\text{COONa}$ .	$\text{C}_4\text{H}_7\text{COOAg}$ .	$\text{C}_4\text{H}_7\text{COONa}$ .	C
0.0	0.0224	0.0	4.363	0.0658	0.0091	7.24	I
0.0066	0.0199	0.73	3.881	0.1315	0.0060	14.47	I
0.0164	0.0169	1.81	3.296	0.263	0.0040	28.96	0.
0.0329	0.0131	3.62	2.555	0.493	0.0027	54.28	0.



**SILVER CAPROATES**  $\text{Ag}(\text{C}_6\text{H}_{11}\text{O}_2)$ .

## SOLUBILITY OF EACH SEPARATELY IN WATER.

(Keppiah, 1888; Stiasny, 1891; Kulisch, 1893; König, 1894; Altschul, 1896.)

Results in terms of gms. salt per 100 gms.  $\text{H}_2\text{O}$ .

Normal Caproate $\text{CH}_3(\text{CH}_2)_4\text{COOAg}$ .	2 Methyl Pentan Acid $\text{CH}_3\text{CH}(\text{CH}_2)_3\text{COOAg}$ .	Methyl 3 Pentan Acid $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOAg}$ .	4 Methyl Pentan Acid $\text{CH}_3(\text{CH}_2)_3\text{CH}(\text{CH}_2)_2\text{COOAg}$ .
0.076 (A.)	0.078 (Keppiah)	0.168 (König)	0.880 (Kulisch)
0.085	0.089	0.162	0.858
0.100	0.107	0.163	0.849
0.123	0.131	0.170	0.854
0.154	0.161	0.183	0.871
0.193	0.198	0.203	0.902
0.240	0.243	0.229	0.946
0.295	0.288	0.263	1.003
0.354	...	0.300	1.073
...	...	0.347	1.157
			...

**SILVER CARBONATE**  $\text{Ag}_2\text{CO}_3$ .

## SOLUBILITY IN WATER.

t°.	Gms. $\text{Ag}_2\text{CO}_3$ per Liter.	Authority.
15	0.031	(Kremers, 1852.)
25	0.033 (0.00012 gm. atoms Ag.)	(Abegg and Cox, 1903.)
25	0.032 (by potential measurement)	(Spencer and Le Pla, 1909.)
100	0.50	(Joulin, 1873.)
15	0.85 (in $\text{H}_2\text{O}$ sat. with $\text{CO}_2$ )	(Johnson, 1886.)

**SILVER CHLORATE**  $\text{AgClO}_3$ .0 gms. cold water dissolve 10 gms.  $\text{AgClO}_3$  (Vauquelin); 20 gms.  $\text{AgClO}_3$  (other).**SILVER CHLORIDE**  $\text{AgCl}$ .

## SOLUBILITY IN WATER.

Large number of determinations are quoted by Abegg and Cox, 1903; see also Kohlrausch, 1904-05; 1903, 1906.)

t°.	14°.	20°.	25°.	42°.	100°.
AgCl per Liter	0.0014	0.0016	0.0020	0.0040	0.0218

Recent determinations are as follows:

Gms. AgCl per Liter.	Method.	Authority.
0.00089	Conductivity	(Kohlrausch, 1908.)
0.00150	Conductivity	(Melcher, 1910.)
0.00154	Colorimetric (See Note, p. 608)	(Whitby, 1910.)
0.00172	Analytical	(Glowczynski, 1914.)
0.00523	Conductivity	(Melcher, 1910.)
0.02107	"	(Melcher, 1910.)
0.0217	Colorimetric	(Whitby, 1910.)

in the case of determination by Glowczynski, one liter of sat. solution was treated with freshly dis-  
 ammonia and evaporated to dryness in a platinum dish. The residue was dissolved in strong am-  
 monia and again evaporated. The residue then dissolved in 5-6 cc. of 0.05 N KCN and the silver separated  
 gravimetrically, dissolved in  $\text{HNO}_3$  and titrated with 0.01 N  $\text{NH}_4\text{SCN}$ .

Comparative determinations of the solubilities of  $\text{AgCl}$ ,  $\text{AgSCN}$ ,  $\text{AgBr}$  and  $\text{AgI}$   
 at 25°, showed that if the solubility of  $\text{AgCl}$  be taken as 1, that of  $\text{AgSCN}$   
 748, that of  $\text{AgBr}$  is 0.0550 and that of  $\text{AgI}$  is 0.00077. (Hill, 1908.)



# SILVER CHLORIDE

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## SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS AMMONIA SOLUTIONS AT 25°

(Whitney and Melcher, 1903.)

(Straub, 1911.)

Gm. Mols. NH <sub>3</sub> (total) per Liter.	Gm. Atoms Ag per Liter.	Gm. Mols. NH <sub>3</sub> (total) per 1000 Gms. H <sub>2</sub> O.	Gm. Atoms Ag per 1000 Gms. H <sub>2</sub> O.	Solid Phase
0.0282	0.00141	0.0428	0.025	AgCl
0.0288	0.00149	1.688	0.1308	"
0.0590	0.00304	3.782	0.372	"
0.118	0.00621	3.945	0.378	"
0.253	0.0140	5.10	0.574	"
0.397	0.0227	5.33	0.609	"
0.428	0.0249	5.545	0.633	"
0.818	0.0514	6.26	0.754	" + 2AgCl · 3NH <sub>3</sub>
0.863	0.0541	6.52	0.775	2AgCl · 3NH <sub>3</sub>
0.896	0.0569	8.28	0.848	"
0.909	0.0584	11.78	0.980	"
0.961	0.0616	12.68	1.030	"
1.991	0.147	12.96	1.090	"
2.042	0.151	14.47	1.039	"

Additional data for the above system at 25° are given by Bodländer and Fittig (1901-02). These authors also give results showing the effect of KCl and of AgNO<sub>3</sub> on the solubility of AgCl in aqueous ammonia. Determinations at 15° are given by Bodländer (1892).

## SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF:

Ammonia at 0°.  
(Jarry, 1899.)

Monomethyl Amine at 11.5°  
(Jarry.)

Gms. per 100 Gms. Solution.				Gms. per 100 Gms. Solution.	
NH <sub>3</sub> Gas.	AgCl.	NH <sub>3</sub> Gas.	AgCl.	NH <sub>3</sub> CH <sub>3</sub> .	AgCl.
1.45	0.49	28.16	6.50	1.78	0.16
2.94	1.36	29.80	7.09	4.44	0.62
5.60	3.44	30.19	7.25	5.51	0.83
6.24	4	32.43	5.87	7.66	1.32
11.77	4.68	34.56	4.77	13.70	3.29
16.36	5.18	37.48	3.90	18.69	5.43
				36.69	9.93

## SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF AMMONIUM OXALATE (Longi, 1883; at 25°, Valenta, 1894; at 80°, Pohl, 1860.)

Solvent.	Sp. Gr.	°.	Gms. AgCl 100 Gms. Solv.
Aq. Ammonia of 0.998	5%	12	0.2
" 0.96	10%	18	7.8
" 0.986		80	1.4
"	3%	25	1.4
"	15%	25	7.58



**SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF METHYL AMINE AND OF ETHYL AMINE AT 25°.**

(Bodländer and Eberlein, 1903; Wuth, 1902; Euler, 1903.)

**Results for Methyl Amine.**

Mols. per Liter.

Base.	AgCl.	Free Base.
0.17	0.0387	0.940 (B. & E.)
0.3	0.0335	... (E.)
0.08	0.0178	0.472 (B. & E.)
0.03	0.0068	0.189 "
0.02	0.0036	0.0050 "
0.95	0.00048	... (W.)
0.74	0.00042	... "
0.20	0.00030	... "

**Results for Ethyl Amine.**

Mols. per Liter.

Total Base.	AgCl.	Free Base.
0.483	0.0314	0.420 (B. & E.)
0.200	0.0115	0.177 "
0.100	0.0062	0.088 "
0.094	0.0048	... (E.)
0.050	0.0029	0.044 (B. & E.)
0.103	0.00824	... (W.)
0.0551	0.000235	... "
0.0127	0.000114	... "

**SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE.**

(Schieberholz, 1890; see also Vogel, 1874; Hahn, 1877.)

**Solubility at 15°.**

Gms. per 100 Gms. Solution.

NH <sub>4</sub> Cl.	AgCl.
10	0.0050
14.29	0.0143
17.70	0.0354
19.23	0.0577
21.91	0.110
25.31	0.228
28.45	0.340 (24.5)
at ord. temp.	0.157

**Solubility at Different Temperatures.**

Gms. per 100 Gms. Solution.

t°.	NH <sub>4</sub> Cl.	AgCl.
15	26.31	0.276
40	"	0.329
60	"	0.421
80	"	0.592
90	"	0.711
100	"	0.856
110	"	1.053

Sp. Gr. of 26.31% NH<sub>4</sub>Cl solution at 15° = 1.08.

ne liter aq. sol. containing 0.00053 gm. NH<sub>4</sub>Cl dissolves 0.001604 gm. AgCl

5°.

ne liter aq. sol. containing 0.00530 gm. NH<sub>4</sub>Cl dissolves 0.002379 gm. AgCl

10°.

(Głowczyński, 1914.)

**SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE AT 25°.**

(Forbes, 1911.)

Mm. Equiv. per Liter.		Gms. Equiv. per Liter.		Gms. Equiv. per Liter.	
NH <sub>4</sub> Cl.	Ag.	NH <sub>4</sub> Cl.	Ag.	NH <sub>4</sub> Cl.	Ag.
5.13	0.000042	2.566	0.001425	4.777	0.0135
0.26	0.000113	2.918	0.002160	4.902	0.01492
0.41	0.000172	3.162	0.002795	5.503	0.02404
5.74	0.000365	3.510	0.004029	5.764	0.03017
0.43	0.000842	4.363	0.009353		

These determinations were made by gradually adding 0.25 N and 0.01 N AgNO<sub>3</sub> chloride solution and observing the point of initial opalescence.

**SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF ALUMINIUM AND AMMONIUM SALTS.**

(Valenta; see also Cohn, 1895.)

Aq. Salt Solution.	t°.	Gms. AgCl per 100 Gms. Solvent of Concentration:		
		1 : 100.	5 : 100.	10 : 100.
Aluminium Thiocyanate	25	...	...	2.02
Ammonium Carbonate	25	...	...	0.05
" Thiocyanate	20	...	0.08	0.54
" Thiosulfate	20	0.57	1.32	3.92
" "	Calc. by Cohn*	0.64	3.07	5.86

\* See Note, p. 603.



SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF BARIUM  
CHLORIDE AND OF CALCIUM CHLORIDE.  
(Forbes, 1911.)

Aq. Solution of:	t°.	Gms. Equiv. per Liter.		Aq. Solution of:	t°.	Gms. Equiv. per Liter.	
		$\text{BaCl}_2$	Ag.			$\text{CaCl}_2$	Ag.
Barium Chloride	25	1.248	0.000186	Calcium Chloride	25	3.264	0.001463
"	25	1.610	0.000339	"	25	3.737	0.00182
"	25	2.676	0.001274	"	25	4.033	0.002802
"	25	3.260	0.002366	"	25	4.533	0.004175
Calcium Chloride	25	1.748	0.000289	"	25	5.005	0.005823
"	25	2.201	0.000501	"	1	3.512	0.000604
"	25	2.741	0.000900	"	25	3.320	0.005114
				"	35	3.221	0.001806



OF SILVER CHLORIDE IN AQUEOUS SALT SOLUTIONS.  
(Vogel; Hahn; Valenta)

	Conc. of Salt.	t°.	Gms. AgCl per 100 Gms. Solution.
ide	27.32%	24.5	0.057 (H.)
ide	saturated	ord. temp.	0.014 (Vg.)
ocyanide	10:100	25	0.20 (Vl.)
ocyanide	10:100	25	0.15 (Vl.)
ide	41.26%	24.5	0.571 (H.)
ide	saturated	ord. temp.	0.093 (Vg.)
ide	"	24.5	0.053 (H.)
ide	"	"	0.169 (H.)
ide	"	"	0.006 (H.)
chloride	"	"	0.013 (H.)
chloride	50:100	25	0.50 (Vl.)
chloride	36.35%	24.5	0.531 (H.)
chloride	saturated	ord. temp.	0.171 (Vg.)
loride	"	"	0.088 (Vg.)
ide	"	24.5	0.0134 (H.)
loride	"	ord. temp.	0.0475 (Vg.)
loride	24.95%	19.6	0.0776 (H.)
anide	5:100	25	2.75 (Vl.)
anide	5:100	25	5.24 (Cohn*)
lphocyanide	10:100	25	0.11 (Vl.)
ide	saturated	ord. temp.	0.095 (Vg.)
ide	25.95%	19.6	0.105 (H.)

\* See Note, p. 603.

OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF NITRIC  
ACID AT 25°.  
(Glowczynski, 1914.)

Mols. per Liter.		Gms. per Liter.	
H <sub>2</sub> O	AgCl.	HNO <sub>3</sub>	AgCl.
0.05	1.15 · 10 <sup>-5</sup>	0.0315	0.001647
0.1	1.19 · 10 <sup>-5</sup>	0.063	0.001705
0.2	1.24 · 10 <sup>-5</sup>	0.630	0.00176
0.3	1.57 · 10 <sup>-5</sup>	18.9	0.00225
0.4(?)	1.71 · 10 <sup>-5</sup>	94.5	0.00245

OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM  
CHLORIDE AT 25°.

(Forbes, 1911.)

(Glowczynski, 1914.)

gr.	Gms. Equiv. per Liter.		Mols. per Liter.		Gms. per Liter.	
	KCl.	Ag.	KCl.	AgCl.	KCl.	AgCl.
11	2.850	0.001845	3.16 · 10 <sup>-5</sup>	1.28 · 10 <sup>-5</sup>	0.00236	0.001836
15	3.081	0.002435	6.32 · 10 <sup>-5</sup>	1.52 · 10 <sup>-5</sup>	0.00471	0.002178
11	3.424	0.003602	2.0 · 10 <sup>-4</sup>	2.13 · 10 <sup>-5</sup>	0.01491	0.003052
16	3.843	0.005725	4.0 · 10 <sup>-4</sup>	2.24 · 10 <sup>-5</sup>	0.02984	0.003209
10	3.325	0.001734 (at 1°)				
10	2.955	0.002786 (at 35°)				

nations of Glowczynski were made by the method described in 5. The determinations of Forbes were made by gradually adding 1 N AgNO<sub>3</sub> to the chloride solution and observing the point of nce.

aq. KCl dissolves 0.00637 gm. mol. = 0.915 gm. AgCl at 25°.  
(Hellwig, 1900.)



## SILVER CHLORIDE

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## SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF POTASSIUM CHLORIDE AT 15°.

(Schierholz — Sitzber. K. Akad. Wiss. (Vienna) 101, 2b, 8, '90.)

Grams per 100 Grams Solution.		Grams per 100 Grams Solution.	
KCl.	AgCl.	KCl.	AgCl.
10.0	0.000	22.47	0.045
14.29	0.004	24.0	0.072
16.66	0.008	25.0	0.084
20.00	0.020	Sp. Gr. of 25% KCl sol., = 1.179	

## MIXTURES OF SILVER CHLORIDE AND SILVER HYDROXIDE IN EQUILIBRIUM WITH AQUEOUS POTASSIUM HYDROXIDE SOLUTIONS AT 25°.

(Noyes and Kohr — J. Am. Ch. Soc. 24, 1144, '02.)

Normality of KOH.	Millimols per Liter.		Grams per Liter.		
	KCl.	KOH.	KCl.	KOH.	AgCl.
0.333	3.414	347.8	0.255	10.05	0.4896
0.065	0.598	65.0	0.0446	2.00	0.0828

## SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SODIUM CHLORIDE SOLUTIONS (Schierholz; Vogel; Hahn.)

Solubility at 15°.		Solubility at Different Temperatures.		
Gms. per 100 Gms. Solution.		t°.	Gms. AgCl per 100 Gms. Solution in:	
NaCl.	AgCl.		14% NaCl	26.3% NaCl
10.0	0.0025	15	0.007	0.128
14.29	0.0071	30	0.011	0.132
18.18	0.0182	40	0.014	0.158
21.98	0.0439	50	0.023	0.184
23.53	0.0706	70	0.042	0.263
25.64	0.103	80	0.054	0.315
26.31	0.127	90	0.069	0.368
		100	0.090	0.460
Sp. Gr. of 26.31% NaCl sol. = 1.207.		109	0.107 (104°)	0.571

## SOLUBILITY AT 20°, 50°, AND 90° (CALC. FROM ORIGINAL)

(Barlow — J. Am. Chem. Soc. 28, 1446, '06.)

Gms. NaCl per 100 cc. Solution.	Gms. AgCl dissolved per 100 cc. Solution at:			Gms. NaCl per 100 cc. Solution.	Gms. AgCl dissolved per 100 cc. Solution at:		
	20°.	50°.	90°.		20°.	50°.	90°.
3.43	0.00018	0.0016	0.0067	11.5	0.0031	0.0124	0.04
4.60	0.00025	0.0025	0.0100	15.3	0.0090	0.0191	0.07
5.75	0.00047	0.0034	0.0135	23.0	0.0313	0.0889	0.170
7.67	0.00125	0.0058	0.0236				

Results are also given for the solubility of silver chloride in aqueous sodium chloride solutions containing hydrochloric acid.

## SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SODIUM CHLORIDE AT 25° (Forbes, 1911.)

Gms. Equiv. per Liter.		Gms. Equiv. per Liter.		Gms. Equiv. per Liter.	
[NaCl].	[Ag] × 10 <sup>3</sup> .	[NaCl].	[Ag] × 10 <sup>3</sup> .	[NaCl].	[Ag] × 10 <sup>3</sup> .
0.933	0.086	2.272	0.570	3.747	2.462
1.190	0.130	2.658	0.851	3.977	2.879
1.433	0.184	2.841	1.040	4.363	3.810
1.617	0.245	3.270	1.583	4.535	4.298
1.871	0.348	3.471	1.897	5.039	6.039



## SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SODIUM NITRATE SOLUTIONS.

t°.	Gms. per 100 Gms. H <sub>2</sub> O.		t°.	Gms. per 100 Gms. H <sub>2</sub> O.	
	NaNO <sub>3</sub> .	AgCl.		NaNO <sub>3</sub> .	AgCl.
5	0.787	0.00086	15-20	0.393	0.00096
8	0.787	0.00146	"	0.787	0.00133
10	0.787	0.00233	"	2.787	0.00253
15-55	0.787	0.00399		(Mulder.)	

liter aq. 3  $\pi$  AgNO<sub>3</sub> dissolves 0.0056 gm. mols. = 0.8 gm. AgCl at 25°.  
(Hellwig, 1900.)

## SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SODIUM SULFITE SOLUTIONS AT 25°.

(Luther and Leubner, 1912.)

Gms. Formula Weight per Liter.		Gms. Formula Weight per Liter.	
SO <sub>2</sub> ".	Ag'.	SO <sub>2</sub> ".	Ag'.
0.080	0.011	0.483	0.059
0.106	0.017	0.470	0.070
0.220	0.033	0.652	0.103
0.234	0.036	0.890	0.140
0.478	0.057	0.937	0.142

AgCl was prepared by precipitating dilute AgNO<sub>3</sub> with alkali chloride at pt. The resulting solid corresponded to the granular modification of Stas. one hour constant agitation was allowed for attainment of equilibrium.

## SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS SOLUTIONS OF SODIUM THIOSULFATE, ETC.

(Valenta; Cohn; Richards and Faber, 1899.)

Salt Solution.	t°.	Gms. AgCl per 100 Gms. Aq. Solutions of Concentration:				
		1:100.	5:100.	10:100.	15:100.	20:100.
Sodium Sulfite	25	...	...	0.44	...	0.95
Sodium Thiosulfate	20	0.40	2	4.10	5.50	6.10
"	Calc. by Cohn.*	0.38	1.83	3.50	5.02	6.41
Sodium Thiosulfate	35	...	...	...	...	9.08†
Urea carbamide	25	...	...	0.83	...	...
Cyanimine	25	0.40	1.90	3.90	...	...

\* See Note, p. 603.

† Gms. per 100 cc. solution (R. and F.).

## SOLUBILITY OF SILVER CHLORIDE IN AQUEOUS STRONTIUM CHLORIDE AT 25°.

(Forbes, 1911.)

Gms. Equiv. per Liter.		Gms. Equiv. per Liter.		Gms. Equiv. per Liter.	
$\frac{\text{SrCl}_2}{2}$ .	Ag $\times 10^3$ .	$\frac{\text{SrCl}_2}{2}$ .	Ag $\times 10^3$ .	$\frac{\text{SrCl}_2}{2}$ .	Ag $\times 10^3$ .
0.550	0.033	1.818	0.348	3.494	2.018
0.980	0.092	2.140	0.510	4.152	3.594
1.359	0.173	2.476	0.747	5.216	8.174
1.572	0.236	2.992	1.252	5.775	12.040

determinations were made by gradually adding 0.25  $\pi$  and 0.01  $\pi$  AgNO<sub>3</sub> to chloride solution and observing the point of initial opalescence.

liter of 4.777  $\pi$  ZnCl<sub>2</sub> solution dissolves 0.000364 mol. AgCl at 25°.

(Forbes, 1911.)

ion-point data are given for the following mixtures.

AgCl + AgI.	(Monkemeyer, 1906.)
AgCl + Ag <sub>2</sub> S.	(Truthe, 1912; Sandonnini, 1912.)
AgCl + NaCl.	(Sackur, 1913; Botta, 1911; Sandonnini, 1911, 1914.)
AgCl + TiCl.	(Sandonnini, 1911, 1914.)



SOLUBILITY OF SILVER CHLORIDE IN PYRIDINE.  
(Kahlenberg and Wittich, 1909.)

t°.	Gms. AgCl per 100 Gms. Pyridine.	Solid Phase.	t°.	Gms. AgCl per 100 Gms. Pyridine.	Solid Phase.
-57 Eutec.	...	AgCl.2C <sub>5</sub> H <sub>5</sub> N+C <sub>5</sub> H <sub>5</sub> N	0	5.35	AgCl
-49	0.77	AgCl.2C <sub>5</sub> H <sub>5</sub> N	10	3.17	"
-35	0.99	"	20	1.91	"
-30	1.36	"	30	1.20	"
-25	1.80	"	40	0.80	"
-22	2.20	"	50	0.53	"
- tr. pt.	2.75	" +AgCl.C <sub>5</sub> H <sub>5</sub> N	60	0.403	"
-20	3.75	AgCl.C <sub>5</sub> H <sub>5</sub> N	70	0.32	"
-18	3.85	"	80	0.25	"
-10	4.35	"	90	0.22	"
-5	5.05	"	100	0.18	"
-1	5.60	"	110	0.12	"

**SILVER CHROMATE** Ag<sub>2</sub>CrO<sub>4</sub>.

One liter of water dissolves 0.026 gm. Ag<sub>2</sub>CrO<sub>4</sub> at 18°, and 0.020 gm. at 25°.  
(Abegg and Cox, 1903; Kohlrausch, 1904-05.)  
One liter H<sub>2</sub>O dissolves 0.029 gm. Ag<sub>2</sub>CrO<sub>4</sub> at 25°. (Schäfer, 1905.)  
One liter of H<sub>2</sub>O dissolves 0.0142 gm. Ag<sub>2</sub>CrO<sub>4</sub> at 0.26°; 0.0225 gm. at 14.8°,  
0.036 gm. at 30.7° and 0.084 gms. at 75°. (Kohlrausch, 1908.)  
One liter H<sub>2</sub>O dissolves 0.0256 gm. at 18°, 0.0341 gm. at 27° and 0.0534 gm. at  
50°, determined by a colorimetric method (see Note, p. 608). (Whitby, 1911)

SOLUBILITY OF SILVER CHROMATE IN AQUEOUS AMMONIA AT 25°.  
(Sherrill and Eaton, 1907.)

Mols. NH <sub>4</sub> OH per Liter	0.01	0.02	0.04	0 —
Mols. × 10 <sup>3</sup> Ag <sub>2</sub> CrO <sub>4</sub> per Liter	2.004	4.169	8.595	17 —

SOLUBILITY OF SILVER CHROMATE IN AQUEOUS NITRIC ACID AT 25°  
(Sherrill and Russ, 1907.)

Mols. HNO <sub>3</sub> per Liter.	Milliatoms per Liter.		Solid Phase.	Mols. HNO <sub>3</sub> per Liter.	Milliatoms per Liter.		Solid Phase.
	Cr.	Ag.			Cr.	Ag.	
0.01	3.157	6.315	Ag <sub>2</sub> CrO <sub>4</sub>	0.06	6.833	...	Ag <sub>2</sub> CrO <sub>4</sub>
0.015	3.730	...	"	0.07	7.333	...	"
0.02	4.177	8.356	"	0.075	7.477	14.85	" +
0.025	4.567	...	"	0.08	7.260	15.45	"
0.03	5.200	...	"	0.10	5.647	19.01	"
0.04	5.803	11.62	"	0.13	4.293	23.80	"
0.05	6.380	...	"	0.14	3.948	25.63	"

One liter 65% aqueous alcohol dissolves  $0.78 \times 10^{-4}$  gms. equivalents = 0.0  
gm. Ag<sub>2</sub>CrO<sub>4</sub> at room temp. (?). (Guerin, 1915)

SOLUBILITY OF SILVER CHROMATE IN AQUEOUS SOLUTIONS OF NITRATES AT 10°  
(Carpenter, 1886.)

Solvent.	Gms. Salt per 100 cc. H <sub>2</sub> O.	Gms. Ag <sub>2</sub> CrO <sub>4</sub> per 100 cc. Solution.
Water	0	0.064
Sodium Nitrate	50	0.064
Potassium Nitrate	50	0.192
Ammonium Nitrate	50	0.320
Magnesium Nitrate	50	0.256



**IR (Di) CHROMATE**  $\text{Ag}_2\text{Cr}_2\text{O}_7$ .

liter of aqueous solution contains 0.00019 gm. mol. or 0.083 gm.  $\text{Ag}_2\text{Cr}_2\text{O}_7$   
(Mayer, 1903.)

**SOLUBILITY OF SILVER DICHROMATE IN AQUEOUS NITRIC ACID AT 25°.**

(Sherrill and Russ, 1907.)

Vol. $\text{HNO}_3$ per Liter.	Milliatoms per Liter.		Solid Phase.
	Cr.	Ag.	
0	32.20	5.390	$\text{AgCrO}_4 + \text{Ag}_2\text{Cr}_2\text{O}_7$
0.01	25.06	6.131	" "
0.02	20.21	7.148	" "
0.04	13.59	9.529	" "
0.06	11.10	11.1	$\text{Ag}_2\text{Cr}_2\text{O}_7$
0.08	11.1	11.1	"
0.08 + 0.1 $\text{AgNO}_3$	6.625	...	"

the lower concentrations some of the dichromate is converted into solid state.

**IR CITRATE**  $\text{C}_6\text{H}_5\text{O}_7\text{Ag}_3$ .

gms.  $\text{H}_2\text{O}$  dissolve 0.0277 gm.  $\text{C}_6\text{H}_5\text{O}_7\text{Ag}_3$  at 18°, and 0.0284 gm. at 25°.  
(Partheil and Hübner, 1903.)

**IR CYANIDE**  $\text{AgCN}$ .

liter of aqueous solution contains 0.000043 gm.  $\text{AgCN}$  at 17.5° and 0.00022 gm. at 20° (by Conductivity Method).  
(Abegg and Cox; Böttger, 1903.)

**SOLUBILITY OF SILVER CYANIDE IN AQUEOUS AMMONIA SOLUTIONS.**

(Longi, 1883.)

gms. aq. ammonia of 0.998 Sp. Gr. = 5%, dissolve 0.232 gm.  $\text{AgCN}$  at 12°.  
gms. aq. ammonia of 0.96 Sp. Gr. = 10%, dissolve 0.542 gm.  $\text{AgCN}$  at 18°.

liter aq. 3%  $\text{AgNO}_3$  dissolves 0.0091 gm. mol. = 1.216 gm.  $\text{AgCN}$  at 25°.  
(Hellwig, 1900.)

ion-point data for mixtures of  $\text{AgCN} + \text{NaCN}$  are given by Truthe (1912).

**IR FERRICYANIDE**  $\text{Ag}_3\text{FeCN}_6$ .

liter  $\text{H}_2\text{O}$  dissolves 0.00066 gm.  $\text{Ag}_3\text{FeCN}_6$  at 20°. See Note, p. 608.  
(Whitby, 1910.)

**IR SODIUM CYANIDE**  $\text{AgCN} \cdot \text{NaCN}$ .

gms.  $\text{H}_2\text{O}$  dissolve 20 gms. at 20°, and more at a higher temperature. 100% alcohol dissolve 4.1 gms. at 20°.  
(Baup, 1858.)

**IR THALLOUS CYANIDE**  $\text{AgCN} \cdot \text{TlCN}$ .

gms.  $\text{H}_2\text{O}$  dissolve 4.7 gms. at 0°, and 7.4 gms. at 16°. (Fronmüller, 1878.)

**IR FLUORIDE**  $\text{AgF} \cdot 2\text{H}_2\text{O}$ .**SOLUBILITY IN WATER.**

(Guntz and Guntz, Jr., 1914.)

t°.	Gms. AgF per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. AgF per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase
-12 Eutec.	60	Ice + $\text{AgF} \cdot 4\text{H}_2\text{O}$	25	179.5	$\text{AgF} \cdot 2\text{H}_2\text{O}$
-5	165	$\text{AgF} \cdot 4\text{H}_2\text{O}$	28.5	215	"
-65	169.5	" + $\text{AgF} \cdot 2\text{H}_2\text{O}$	32	193	"
	172	$\text{AgF} \cdot 2\text{H}_2\text{O}$	39.5	222	" + AgF
	178	"	108	205	AgF

unstable hydrates,  $\text{AgF} \cdot \text{H}_2\text{O}$  and  $3\text{AgF} \cdot 5\text{H}_2\text{O}$  were also obtained.

gms.  $\text{H}_2\text{O}$  dissolve 181.8 gms. AgF at 15.8°,  $d_{15.8}$  of Sat. Sol. = 2.61. (Gore, 1870.)



# SILVER FLUORIDE

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## SOLUBILITY OF SILVER FLUORIDE IN AQUEOUS SOLUTIONS OF HYDROFLUORIC ACID AT 0° AND AT 24°.

(Guntz and Guntz, Jr., 1914.)

Results			Results at 24°.		
Gms. per 100	Gms. H <sub>2</sub> O. <sup>1</sup>	Solid Phase.	Gms. per 100	Gms. H <sub>2</sub> O.	Solid Phase.
AgF.	HF.		AgF.	HF.	
87.5	0.40	AgF. <sub>4</sub> H <sub>2</sub> O	178	0	AgF. <sub>2</sub> H <sub>2</sub> O
89.4	2.60	"	178.5	1.73	"
93.8	3.97	"	177.65	5.42	"
118.5	9.60	"	179.5	10	"
156	14	" + AgF. <sub>2</sub> H <sub>2</sub> O	189.5	13.4	"
159	17.2	AgF. <sub>2</sub> H <sub>2</sub> O	191.5	14.3	" + AgF(?)
185	24	"	207	0.15	3 AgF. <sub>5</sub> H <sub>2</sub> O
189	25.7	AgF	206.2	1.25	"
188	29.5	"	202.5	7.9	"
196	39.8	"	198.6	12.65	"
142.1	52	AgF. <sub>2</sub> H <sub>2</sub> O	195.5	11.7	AgF. <sub>2</sub> H <sub>2</sub> O
121.75	57.2	"	194.5	13	"
94.93	66.57	"	189.5	18.8	3 AgF. <sub>5</sub> H <sub>2</sub> O + AgF(?)
173.75	0.4	3 AgF. <sub>5</sub> H <sub>2</sub> O	193	36.6	AgF
174	3.6	"	193.5	16	

Additional determinations at other temperatures are given.

# SILVER FULMINATE CAg<sub>2</sub>(NO<sub>2</sub>)CN.

One liter of aqueous solution contains 0.075 gm. C<sub>2</sub>Ag<sub>2</sub>N<sub>2</sub>O<sub>2</sub> at 13°, and 0.180 gm. at 30° (Holleman, 1896.)

# SILVER HEPTOATE (Önanthylate) AgC<sub>7</sub>H<sub>15</sub>O<sub>2</sub>.

SOLUBILITY IN WATER.  
(Landau, 1893; Altschul, 1896.)

°.	Gms. AgC <sub>7</sub> H <sub>15</sub> O <sub>2</sub> per 100 Gms. H <sub>2</sub> O.		°.	Gms. AgC <sub>7</sub> H <sub>15</sub> O <sub>2</sub> per 100 Gms. H <sub>2</sub> O.	
0	0.0635 (Landau)	0.0436 (Altschul)	50	0.1652 (Landau)	0.0858 (Altschul)
10	0.0817	0.0494	60	0.1906	0.1036
20	0.1007	0.0555	70	0.2185	0.1351
30	0.1206	0.0617	80	0.2495	0.1688
40	0.1420	0.0714			

# SILVER IODATE AgIO<sub>3</sub>.

One liter of aqueous solution contains 0.04 gm. or 0.00014 gm. mol. at 18°-20°, and 0.05334 gm. or 0.000189 gm. mol. at 25°.

(Longi; Böttger; Kohlrausch; Noyes and Kohr, 1902.)

The solubility of silver iodate in water, determined by a colorimetric method (see Note, p. 608), was found by Whitby (1910) to be 0.039 gm. AgIO<sub>3</sub> per liter at 20°. Determinations reported by Sammet (1905) made by a chain cell method, gave 0.0611 gm. AgIO<sub>3</sub> per liter at 25° and 0.1849 gm. at 60°.

One liter of H<sub>2</sub>O dissolves 0.0275 gm. AgIO<sub>3</sub> at 9.43°, 0.039 gm. at 18.4° and 0.0539 gm. at 26.6° (Kohlrausch, 1908.)

## SOLUBILITY OF SILVER IODATE IN AQUEOUS SOLUTIONS OF AMMONIA AND OF NITRIC ACID AT 25°.

(Longi, 1883.)

100 gms. aq. ammonia of 0.998 Sp. Gr. = 5% dissolve 2.36 gms. AgIO<sub>3</sub>.  
100 gms. aq. ammonia of 0.96 Sp. Gr. = 10% dissolve 45.41 gms. AgIO<sub>3</sub>.  
100 gms. aq. nitric acid of 1.21 Sp. Gr. = 35% dissolve 0.096 gm. AgIO<sub>3</sub>.



TABLE I  
SOLUBILITY OF SILVER IODATE IN AQUEOUS SOLUTIONS OF NITRIC ACID AT 25°.  
(Hill and Simmons, 1909.)

Normality of Aq. HNO <sub>3</sub> .	Gms. AgIO <sub>3</sub> per Liter.	Normality of Aq. HNO <sub>3</sub> .	Gms. AgIO <sub>3</sub> per Liter.
0	0.0503	1	0.2067
0.125	0.0864	2	0.3319
0.250	0.1075	4	0.6085
0.500	0.1414	8	1.587

The solubility of the amorphous modification of AgIO<sub>3</sub> is considerably higher than that of the crystalline, but the amorphous product rapidly becomes crystalline and the results are soon obtained.

TABLE II  
SOLUBILITY OF SILVER IODIDE IN AQUEOUS AMMONIA.

A 1% aqueous solution contains 0.0000028 gm. AgI at 20°-25°. Several determinations by Kohlrausch, Abegg and Cox, etc., Holleman gives higher figures.) A 1% of water dissolves 0.0000253 gm. AgI at 60°, determined by a chain of (Sammet, 1905). This author also gives data for the solubility of 1% and 0.1% KI solutions at 60°.

TABLE III  
SOLUBILITY OF SILVER IODIDE IN AQUEOUS AMMONIA.

Percent Concentration of Aq. Ammonia.	d of Aq. Ammonia.	t°.	Gms. AgI per Liter.	Authority.
7	0.971	16	0.045	(Ladenburg, 1902.)
10	0.960	12	0.035	(Longi, 1883.)
20	0.926	16	0.166	(Baubigny, 1908.)

They used a sealed tube and noted the first appearance of crystallization in mixtures of known compositions.

TABLE IV  
SOLUBILITY OF SILVER IODIDE IN AQUEOUS MERCURIC NITRATE AT 25°.  
(Morse, 1902.)

NO <sub>3</sub> , per Liter.	Mols. AgI per Liter.	Gms. AgI per Liter.	Mols. Hg(NO <sub>3</sub> ) <sub>2</sub> per Liter.	Mols. AgI per Liter.	Gms. AgI per Liter.
0	0.00340	0.800	0.050	0.00740	1.737
25	0.00358	0.841	0.100	0.01161	2.730
50	0.00476	1.118	1	0.10700	25.160

NO<sub>3</sub> was present in all cases its influence on the solubility was examined, and that no appreciable differences were obtained with concentrations between 0.1 and 2% HNO<sub>3</sub>. Both crystallized and amorphous silver iodide gave identical results.

TABLE V  
SOLUBILITY OF SILVER IODIDE IN AQUEOUS SOLUTIONS OF POTASSIUM IODIDE AND OF SILVER NITRATE AT 25°.  
(Hellwig, 1900.)

Aq. KI Solutions.		In Aq. AgNO <sub>3</sub> Solutions.			
Mols. AgI per Liter.	Gms. AgI per Liter.	Mols. AgNO <sub>3</sub> per Liter.	Mols. AgI per Liter.	Gms. AgI per Liter.	Solid Phase.
0.000363	0.0853	0.20	0.000289	0.068	AgI
0.00218	0.512	0.35	0.000532	0.121	"
0.0044	1.032	0.50	0.00127	0.209	"
0.0141	3.32	0.70	0.00362	0.850	"
0.0148	3.47	1.215	0.0131	3.08	Ag <sub>2</sub> INO <sub>3</sub>
0.0535	12.55	1.63	0.0267	6.26	"
0.0658	15.46	2.04	0.0458	10.9	"
0.102	24.01	2.54	0.0678	16.1	Ag <sub>2</sub> I(NO <sub>3</sub> ) <sub>2</sub>
0.198	46.42	3.75	0.141	33.2	"
		4.69	0.227	53.2	"
		5.90	0.362	85	"



SOLUBILITY OF SILVER IODIDE IN AQUEOUS SALT SOLUTIONS.  
(Valenta, 1894; Cohn, 1895.)

Aq. Salt. Solution.	t°.	Gms. AgI per 100 Gms. Aq. Sol. of Concentration:				
		1:100.	5:100.	10:100.	15:100.	20:100.
Sodium Thiosulfate	20	0.03	0.15	0.30	0.40	0.60
" " Calc. by Cohn.*		0.623	2.996	5.726	8.218	10.493
Potassium Cyanide	25	...	8.28	...	...	...
" " Calc. by Cohn.*		...	8.568	...	...	...
Sodium Sulfite	25	...	...	0.01	...	0.01
Ammonium Thiocyanate	20	...	0.02	0.08	0.13	...
Calcium	25	...	...	0.03	...	...
Barium	25	...	...	0.02	...	...
Aluminium	25	...	...	0.02	...	...
Thiocarbamide	25	...	...	0.79	...	...
Thiocyanime	25	0.008	0.05	0.09	...	...

\* See Note, p. 603.

SOLUBILITY OF SILVER IODIDE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE,  
POTASSIUM BROMIDE AND OF POTASSIUM IODIDE AT 15°.  
(Schierholz, 1890.)

In Sodium Chloride.		In Potassium Iodide.	
Gms. per 100 Gms. Solution.		Gms. per 100 Gms. Solution.	
NaCl.	AgI.	KI.	AgI.
26.31	0.0244	59.16	53.13
25.00	0.00072	57.15	40.0
		50.0	25.0
		40.0	13.0
		33.3	7.33
		25.0	2.75
		21.74	1.576
		20.0	0.80
In Potassium Bromide.			
Gms. per 100 Gms. Solution.			
KBr.	AgI.		
30.77	0.132		

100 gms. sat. silver nitrate solution dissolve 2.3 gms. AgI at 11°, and 12.3 g at b. pt.

100 gms. pyridine dissolve 0.10 gm. AgI at 10°, and 8.60 gms. at 121°.  
(von Laszynyaki, 1)

SOLUBILITY OF SILVER IODIDE IN AQUEOUS SODIUM IODIDE AT 25°.  
(Krym, 1909.)

Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.	Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.
NaI.	AgI.		NaI.	AgI.	
59.29	21.21	AgI	226	120.9	AgI.NaI. <sub>3</sub> H <sub>2</sub> O+
67.47	28.52	"	222.7	112.1	NaI
134.1	99.54	"	214.7	90.84	"
156.9	124.6	"	203.9	59.48	"
179.8	150	" + AgI.NaI. <sub>3</sub> H <sub>2</sub> O	194.5	31.10	"
196.3	134.8	AgI.NaI. <sub>3</sub> H <sub>2</sub> O	185.52	0	"
223.7	122	"			

The above table was calculated from the original results which are expressed mols. per 1000 mols. H<sub>2</sub>O.

Fusion-point data for mixtures of AgI + HgI<sub>2</sub> are given by Steger (190 Results for AgI + NaI are given by Sandonnini and Scarpa (1913).



**R LAURATE, MYRISTATE, PALMITATE and STEARATE**

SOLUBILITY OF EACH, DETERMINED SEPARATELY, IN WATER AND OTHER SOLVENTS AT SEVERAL TEMPERATURES.

(Jacobson and Holmes, 1916.)

Solvent.	t°.	Gms. each Salt per 100 Gms. Solvent.			
		Laurate.	Myristate.	Palmitate.	Stearate.
W	35	...	0.007	0.004	0.004
	50	...	0.007	0.006	0.004
Ethyl Alcohol	25	0.009	0.008	0.007	0.007
	50	0.009	0.008	0.007	0.007
Amyl Alcohol	15	0.074	0.063	0.060	0.051
	25	0.072	0.067	0.059	0.052
"	35	0.078	0.071	0.062	0.055
	50	0.083	0.073	0.066	0.060
W	15	0.010	0.009	0.009	0.007

**R LEVULINATE** (Acetyl propionate)  $\text{CH}_3\text{COCH}_2\text{CH}_2\text{COOAg}$ .

SOLUBILITY IN WATER.

(Furcht and Lieben, 1909.)

t°.	Gms. per 100 Gms. Sat. Solution.	
8	0.5363 (white salt)	0.5195 (yellow salt)
9	0.5166	0.5372
14-15	0.6078	0.6448
99.6	3.49	3.70

**R MALATE**  $\text{C}_4\text{H}_4\text{O}_4\text{Ag}_2$ .

ms.  $\text{H}_2\text{O}$  dissolve 0.0119 gms. at 18°, and 0.1216 gm. at 25°.

(Partheil and Hübner, 1903.)

**R NITRATE**  $\text{AgNO}_3$ .

SOLUBILITY IN WATER.

(Etard, 1894; Kremers, 1854; Tilden and Shenstone, 1884.)

t°.	Gms. $\text{AgNO}_3$ per 100 Gms.		t°.	Gms. $\text{AgNO}_3$ per 100 Gms.	
	Solution.	Water.		Solution.	Water.
5	48 (Etard)	...	50	79 (Etard)	82
0	53	55	60	81.5	84
10	62	63	80	85.5	87
20	68	69	100	88.5	90½
25	70.5	72	120	91	95
30	72.5	75	140	93.5	...
40	76.5	79	160	95	...

ms. sat. aq. solution contain 47.1 gms.  $\text{AgNO}_3$  at -7.3° (= Eutectic).

(Middleberg, 1903.)

ms. sat. aq. sol. contain 65.5 gms.  $\text{AgNO}_3$  at 15.5°.

(Greenish and Smith, 1903.)

ms. sat. aq. sol. contain 73 gms.  $\text{AgNO}_3$  at 30°. (Schreinemakers and de Baat, 1910a.)

**SOLUBILITY OF SILVER NITRATE IN AQUEOUS NITRIC ACID AT 25°.**

(Masson, 1911.)

t.	Gm. Mols. per Liter.		Gms. $\text{AgNO}_3$ per Liter.	$d_{20}$ of Sat. Sol.	Gm. Mols. per Liter.		Gms. $\text{AgNO}_3$ per Liter.
	$\text{HNO}_3$ .	$\text{AgNO}_3$ .			$\text{HNO}_3$ .	$\text{AgNO}_3$ .	
1	0	10.31	1752	1.4980	4.497	2.590	440.1
4	0.4042	9.36	1591	1.4195	5.992	1.698	288.6
3	0.962	8.08	1373	1.3818	8.84	0.843	143.2
2	1.698	6.54	1111	1.3976	12.53	0.347	58.96
2	2.834	4.526	769.1				

ms.  $2\text{HNO}_3 \cdot 3\text{H}_2\text{O}$  dissolve 3.33 gms.  $\text{AgNO}_3$  at 20°, and 16.6 gms. at 100°.

ms. conc.  $\text{HNO}_3$  dissolve 0.2 gm.  $\text{AgNO}_3$ .

(Schultz, 1860.)



## SILVER NITRATE

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SOLUBILITY OF MIXED CRYSTALS OF SILVER NITRATE AND SODIUM NITRATE  
IN AQUEOUS ETHYL ALCOHOL.

(Hissink, 1900.)

Results at 25° in Aq. C <sub>2</sub> H <sub>5</sub> OH of $d_{20} = 0.945$ (37 wt. %).				Results at 50° in Aq. C <sub>2</sub> H <sub>5</sub> OH of $d_{17} = 0.859$ (75 wt. %).			
Gms. per 100 Gms. Sol.		Wt. per cent in Mix Crystals.		Gms. per 100 Gms. Sol.		Wt. per cent in Mix Crystals.	
AgNO <sub>3</sub> .	NaNO <sub>3</sub> .	AgNO <sub>3</sub> .	NaNO <sub>3</sub> .	AgNO <sub>3</sub> .	NaNO <sub>3</sub> .	AgNO <sub>3</sub> .	NaNO <sub>3</sub> .
47.32	0.0	100	0.0	29.78	0.0	100	0.0
44.01	8.78	99.1	0.9	27.9	2.5	99.5	0.5
36.78	20.42	42.9	57.1	26.4	4.2	99.3	0.7
29.97	23.2	33.6	66.4	23.0	6.3	42.9	57.1
24.56	24.82	27.6	72.4	18.3	7.1	31.0	69.0
8.02	26.41	9.9	90.1	9.5	8.3	17.5	82.5
0.0	26.77	0.0	100.0	0.0	8.54	0.0	100.0

Very extensive data for equilibrium in the system silver nitrate, succinic acid nitrile and water are given by Middelberg (1903). This author first gives data for the ternary systems and then results for isotherms of the ternary system at 0°, 12°, 20°, 25° and 26.5°. A number of determinations for higher temperatures are also given. The following compounds of succinic nitrile and silver nitrate were identified: C<sub>2</sub>H<sub>4</sub>(CN)<sub>2</sub>.4AgNO<sub>3</sub>, C<sub>2</sub>H<sub>4</sub>(CN)<sub>2</sub>.2AgNO<sub>3</sub>, C<sub>2</sub>H<sub>4</sub>(CN)<sub>2</sub>.AgNO<sub>3</sub>, 2C<sub>2</sub>H<sub>4</sub>(CN)<sub>2</sub>.AgNO<sub>3</sub>.H<sub>2</sub>O, and 4[2C<sub>2</sub>H<sub>4</sub>(CN)<sub>2</sub>.AgNO<sub>3</sub>]H<sub>2</sub>O. Additional data for this system are also given by Timmermans (1907).

## SOLUBILITY OF SILVER NITRATE IN ALCOHOLS.

(de Bruyn, 1892.)

100 gms. abs. methyl alcohol dissolve 3.72 gms. AgNO<sub>3</sub> at 19°.  
100 gms. abs. ethyl alcohol dissolve 3.10 gms. AgNO<sub>3</sub> at 19°.

## SOLUBILITY OF SILVER NITRATE IN AQUEOUS ETHYL ALCOHOL.

(Eder, 1878.)

Sp. Gr. of Aq. Alcoholic Mixture.	Volume per cent Alcohol.	Gms. AgNO <sub>3</sub> per 100 Gms Aq. Alcohol at:		
		15°.	50°.	75°.
0.815	95	3.8	7.3	18.3
0.863	80	10.3	...	42.0
0.889	70	22.1	...	...
0.912	60	30.5	58.1	89.0
0.933	50	35.8	...	...
0.951	40	56.4	98.3	160.0
0.964	30	73.7	...	...
0.975	20	107.0	214.0	340.0
0.986	10	158.0	...	...

100 gms. of a mixture of 1 vol. (95%) alcohol + 1 vol. ether dissolve 1.6 g AgNO<sub>3</sub> at 15°.

100 gms. of a mixture of 2 vols. (95%) alcohol + 1 vol. ether dissolve 2.3 g AgNO<sub>3</sub> at 15°.

100 gms. H<sub>2</sub>O sat. with ether dissolve 88.4 gms. AgNO<sub>3</sub> at 15°. (Eder, 18

100 gms. acetone dissolve 0.35 gm. AgNO<sub>3</sub> at 14°, and 0.44 gm. at 18°.

(von Laschynski, 1894; Naumann, 19



## SOLUBILITY OF SILVER NITRATE IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. per 100 Gms. Solvent.	Authority.
nitrile (anhydrous)	18	290	(Naumann and Schlier, 1914.)
	ord. temp.	about 150	(Scholl and Steinkopf, 1906.)
nitrile	18	about 105	(Naumann, 1914.)
acetic	35	0.022	(Linebarger, 1895.)
	40.5	0.044	
zinc (anhydrous)	ord. temp.	1 (with decomp.)	(Welsh and Broderson, 1915.)

## SOLUBILITY OF SILVER NITRATE IN PYRIDINE.

(Kahlenberg and Brewer, 1908.)

	Gms. AgNO <sub>3</sub> per 100 Gms. C <sub>5</sub> H <sub>5</sub> N.	Solid Phase.	t°.	Gms. AgNO <sub>3</sub> per 100 Gms. C <sub>5</sub> H <sub>5</sub> N.	Solid Phase.
m. pt.	0	C <sub>5</sub> H <sub>5</sub> N	45	62.26	AgNO <sub>3</sub> ·3C <sub>5</sub> H <sub>5</sub> N
	3	"	46	63.09	"
	6	"	47	66.35	"
	9	"	48	70.85	"
utec.	...	" + AgNO <sub>3</sub> ·6C <sub>5</sub> H <sub>5</sub> N	48.5 tr. pt.	...	" + AgNO <sub>3</sub> ·3C <sub>5</sub> H <sub>5</sub> N
5	11.1	AgNO <sub>3</sub> ·6C <sub>5</sub> H <sub>5</sub> N	45	69.85	AgNO <sub>3</sub> ·3C <sub>5</sub> H <sub>5</sub> N
	11.7	"	50	72.25	"
	12.2	"	60	78.60	"
	12.6	"	70	89.10	"
	13.9	"	80	121.21	"
	17.6	"	87	215.02	"
cr. pt.	...	" + AgNO <sub>3</sub> ·3C <sub>5</sub> H <sub>5</sub> N	80	228.5	"
	18.8	AgNO <sub>3</sub> ·3C <sub>5</sub> H <sub>5</sub> N	74	230.6	"
	20.03	"	74	225.4	"
	22.34	"	80	230.4	"
	27.21	"	87	237.1	"
	33.64	"	90	241.9	"
	40.86	"	100	253.8	"
	53.52	"	110	271.4	"

point data for mixtures of AgNO<sub>3</sub> + TlNO<sub>3</sub> are given by van Eyk (1905).NITRITE AgNO<sub>2</sub>.

## SOLUBILITY IN WATER.

(Creighton and Ward, 1915.)

Gms. AgNO <sub>2</sub> per Liter.	t°.	Gms. AgNO <sub>2</sub> per Liter.	t°.	Gms. AgNO <sub>2</sub> per Liter.
1.55	20	3.40	40	7.15
2.20	25	4.14	50	9.95
2.75	30	5	60	13.63

terminations by Abegg and Pick (1906) are slightly higher than the temperatures below 20°. Single determinations agreeing well with these are given by Ley and Schaefer (1906), and by von Niementowski and Kowski (1897).

## SOLUBILITY IN AQUEOUS SOLUTIONS OF SILVER NITRATE AT 18°.

(Naumann and Rucker, 1905.)

per Liter.	Grams per Liter.		Mols. per Liter		Grams per Liter.	
AgNO <sub>3</sub>	AgNO <sub>2</sub>	AgNO <sub>2</sub>	AgNO <sub>3</sub>	AgNO <sub>2</sub>	AgNO <sub>3</sub>	AgNO <sub>2</sub>
0.02067	0.000	3.184	0.02067	0.01435	3.512	2.201
0.01975	0.439	3.042	0.04134	0.01168	7.024	1.799
0.01900	0.878	2.926	0.08268	0.00961	14.048	1.480
0.01689	1.756	2.601				



## SOLUBILITY OF SILVER NITRITE IN AQUEOUS SOLUTIONS OF SILVER NITRATE AND OF POTASSIUM NITRITE AT 25°.

(Creighton and Ward, 1915.)

In Aqueous AgNO <sub>3</sub> .			In Aqueous KNO <sub>3</sub> .		
Mols. AgNO <sub>3</sub> per Liter.	Dissolved AgNO <sub>3</sub> per Liter.		Mols. KNO <sub>3</sub> per Liter.	Dissolved AgNO <sub>3</sub> per Liter.	
	Mols.	Gms.		Mols.	Gms.
0	0.0269	4.135	0	0.0269	4.135
0.00258	0.0260	3.991	0.00258	0.0259	3.974
0.00588	0.0244	3.735	0.00588	0.0249	3.820
0.01177	0.0224	3.432	0.01177	0.0232	3.560
0.02355	0.0192	2.943	0.02355	0.0203	3.119
0.04710	0.0164	2.498	0.04710	0.0181	2.765

Additional determinations of the solubility of silver nitrite in aqueous silver nitrate solutions at 25° are given by Abegg and Pick (1905).

One liter aqueous 0.02 *N* NaNO<sub>2</sub> dissolves 3.185 gms. AgNO<sub>2</sub> at 25°.

" " " 0.20 *N* " " 3.016 " " "

" " " 0.20 *N* NaNO<sub>2</sub> " 4.956 " " "

(Ley and Schaefer, 1906; see also p. 66a.)

100 gms. H<sub>2</sub>O sat. with both salts contain 10.9 gms. AgNO<sub>2</sub> + 78.3 gms. Sr(NO<sub>3</sub>)<sub>2</sub> at 14°.

(Orwald, 1912, 1914.)

100 gms. acetonitrile dissolve about 23 gms. AgNO<sub>2</sub> at ord. temp. and about 40 gms. at the boiling-point (81.6°).

(Scholl and Steinkopf, 1904.)

SILVER OXALATE Ag<sub>2</sub>C<sub>2</sub>O<sub>4</sub>.

One liter H<sub>2</sub>O dissolves 0.0378 gm. Ag<sub>2</sub>C<sub>2</sub>O<sub>4</sub> at 21°, see Note, p. 608.

(Whitby, 1910.)

One liter H<sub>2</sub>O dissolves 0.0416 gm. Ag<sub>2</sub>C<sub>2</sub>O<sub>4</sub> at 25°. Conductivity method.

(Schaller, 1905.)

One liter H<sub>2</sub>O dissolves 0.0265 gm. Ag<sub>2</sub>C<sub>2</sub>O<sub>4</sub> at 9.72°, 0.034 gm. at 18.5° and 0.043 gm. at 26.9°.

(Kohlrausch, 1904.)

## SOLUBILITY OF SILVER OXALATE IN AQUEOUS NITRIC ACID AT 25°.

(Hill and Simmons, 1909.)

Normality of Aq. HNO <sub>3</sub> .	Per cent Conc. of HNO <sub>3</sub> .	<i>d</i> <sub>20</sub> of Sat. Sol.	Gms. Ag <sub>2</sub> C <sub>2</sub> O <sub>4</sub> per Liter.	Normality of Aq. HNO <sub>3</sub> .	Per cent Conc. of HNO <sub>3</sub> .	<i>d</i> <sub>20</sub> of Sat. Sol.	Gms. Ag <sub>2</sub> C <sub>2</sub> O <sub>4</sub> per Liter.
0.2517	1.574	1.0080	1.345	4.017	22.37	1.1415	17.11
0.5025	3.117	1.0186	2.189	5.564	29.84	1.1996	29.96
0.9806	6.017	1.0339	3.720	5.83	31.085	1.2162	33.88
1.040	11.476	1.0647	7.170				

SILVER OXIDE Ag<sub>2</sub>O.

One liter of H<sub>2</sub>O dissolves 0.021 gm. at 20°, and 0.025 gm. at 25°.

(Noyes and Kohr; Böttger; Abegg and Cos.)

One liter H<sub>2</sub>O dissolves 0.0215 gm. Ag<sub>2</sub>O at 20°. (See Note, p. 608.) (Whitby, 1910.)

## SOLUBILITY OF SILVER OXIDE IN WATER.

(Rebierre, 1915.)

Method of Preparation of the Sample.	Gm. Mols. Ag <sub>2</sub> O per Liter.		Gms. Ag <sub>2</sub> O per Liter.	
	At 25°.	At 50°.	At 25°.	At 50°.
By action of NaOH on AgNO <sub>3</sub>	2.16.10 <sup>-4</sup>	2.97.10 <sup>-4</sup>	0.050	0.0691
By action of Ba(OH) <sub>2</sub> on AgNO <sub>3</sub>	2.23.10 <sup>-4</sup>	3.09.10 <sup>-4</sup>	0.0519	0.0719
By action of KOH on AgCl	2.32.10 <sup>-4</sup>	3.55.10 <sup>-4</sup>	0.0538	0.0825
By action of KOH on Ag <sub>2</sub> CO <sub>3</sub>	2.95.10 <sup>-4</sup>	3.89.10 <sup>-4</sup>	0.0680	0.0904

## SOLUBILITY OF SILVER OXIDE IN AQUEOUS AMMONIA AT 25°.

(Whitney and Melcher, 1903.)

Mols. NH <sub>3</sub> (Total) per Liter.	Gm. Atoms Ag per Liter.	Mols. NH <sub>3</sub> (Total) per Liter.	Gm. Atoms Ag per Liter.	Mols. NH <sub>3</sub> (Total) per Liter.	Gm. Atoms Ag per Liter.
0.220	0.0658	0.733	0.224	1.147	0.343
0.469	0.134	0.876	0.257	1.498	0.454
0.684	0.205	0.915	0.276	1.522	0.470



**SOLUBILITY OF SILVER OXIDE IN AQUEOUS SOLUTIONS OF ETHYL AMINE AND OF METHYL AMINE AT 18°.**

(Euler, 1903.)

**In Aqueous Ethyl Amine.**

Normality of Aq. Amine.	Normality of Dissolved Ag.
0.100	0.0322
0.50	0.160
1	0.314

**In Aqueous Methyl Amine.**

Normality of Aq. Amine.	Normality of Dissolved Ag.
0.100	0.0221
0.500	0.118
1	0.228

**SILVER PERMANGANATE  $\text{AgMnO}_4$ .**

100 gms. cold water dissolve 0.92 gm.: hot water dissolves more.

(Mitscherlich, 1832.)

**SILVER PHOSPHATE  $\text{Ag}_3\text{PO}_4$ .**

1 cc. liter of water dissolves 0.00644 gm. at 20°.

(Böttger, 1903.)

**SILVER PROPIONATE  $\text{C}_2\text{H}_5\text{COOAg}$ .**

**SOLUBILITY IN WATER.**

(Raupenstrauch, 1885; Arrhenius, 1893; Goldschmidt, 1898.)

t°.	Gms. $\text{C}_2\text{H}_5\text{O}_2\text{Ag}$ per Liter.	t°.	Gms. $\text{C}_2\text{H}_5\text{O}_2\text{Ag}$ per Liter.	t°.	Gms. $\text{C}_2\text{H}_5\text{O}_2\text{Ag}$ per Liter.
0	5.12	20	8.36 (8.48)	50	13.35
10	6.78	25	9.06	70	17.64
18.2	8.36 (A)	30	9.93 (9.70)	80	20.30

**SOLUBILITY OF SILVER PROPIONATE IN AQUEOUS SOLUTIONS OF:**

(Arrhenius.)

**Silver Nitrate at 19.7°.**

**Sodium Propionate at 18.2°.**

Mols. per Liter.		Gms. per Liter.		Mols. per Liter.		Gms. per Liter.	
$\text{AgNO}_3$	$\text{C}_2\text{H}_5\text{O}_2\text{Ag}$	$\text{AgNO}_3$	$\text{C}_2\text{H}_5\text{O}_2\text{Ag}$	$\text{C}_2\text{H}_5\text{O}_2\text{Na}$	$\text{C}_2\text{H}_5\text{O}_2\text{Ag}$	$\text{C}_2\text{H}_5\text{O}_2\text{Na}$	$\text{C}_2\text{H}_5\text{O}_2\text{Ag}$
0	0.0471	0	8.519	0	0.0462	0	8.362
0.133	0.0415	2.289	7.511	0.0167	0.0393	1.607	7.114
0.267	0.0379	4.577	6.86	0.0333	0.0345	3.215	6.244
0.533	0.0307	9.059	5.556	0.0667	0.0258	6.429	4.670
1.00	0.0222	16.997	4.019	0.1333	0.0191	12.859	3.456
				0.2667	0.0131	25.718	2.371
				0.5000	0.0101	48.77	1.828

**SILVER SALICYLATE  $\text{C}_6\text{H}_4\text{OH.COOAg}$  1,2.**

1 cc. liter of aqueous solution contains 0.95 gm. at 23°.

(Holleman, 1893.)

**SILVER SUCCINATE  $\text{C}_4\text{H}_4\text{O}_4\text{Ag}_2$ .**

0 gms.  $\text{H}_2\text{O}$  dissolve 0.0176 gm. at 18°, and 0.0199 gm. at 25°.

(Partheil and Hübner, 1903.)

**SILVER SULFATE  $\text{Ag}_2\text{SO}_4$ .**

**SOLUBILITY IN WATER.**

(Barre, 1911.)

t°.	Gms. $\text{Ag}_2\text{SO}_4$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{Ag}_2\text{SO}_4$ per 100 Gms. Sat. Sol.	t°.	Gms. $\text{Ag}_2\text{SO}_4$ per 100 Gms. Sat. Sol.
0	0.57	30	0.88	70	1.21
10	0.69	40	0.97	80	1.28
20	0.79	50	1.05	90	1.34
25	0.834	60	1.14	100	1.39

The result at 25° is the average of the very accurate and closely agreeing determinations of Hill and Simmons (1909), Rothmund (1910) and Harkins (1911). Earlier determinations, differing somewhat from the above, are given by Wright (1904), Wright and Thompson (1884), Wentzel (1891) and Drucker (1901).



# SILVER SULFATE

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## SOLUBILITY OF SILVER SULFATE IN AQUEOUS SOLUTIONS OF AMMONIUM SULFATE.

(Barre, 1911.)

Results at 33°.		Results at 51°.		Results at 75°.		Results at 100°.	
Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.	
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .
8.85	1.101	8.90	1.362	8.80	1.758	9.23	2.221
15.90	1.331	16.27	1.680	15.23	2.155	15	2.626
22.22	1.500	22.43	1.887	22.30	2.490	22.01	3.075
27.25	1.585	32.10	2.061	28.25	2.734	27	3.325
30.80	1.619	35.38	2.095	32	2.823	34.90	3.663
35.88	1.627	39.03	2.082	35.82	2.889	38.70	3.772
39.46	1.600	42.37	2.055	41.16	2.929	44.15	3.854
43.22	1.557	45.05	2.026	46.46	2.902	47.63	3.867

A series of determinations at 16.5° is also given.

## SOLUBILITY OF SILVER SULFATE IN AQUEOUS NITRIC ACID AT 25°.

(Hill and Simmons, 1909.)

Normality of Aq. HNO <sub>3</sub> .	Per cent Conc. of Aq. HNO <sub>3</sub> .	d <sub>m</sub> of Sat. Sol.	Gms. Ag <sub>2</sub> SO <sub>4</sub> per Liter.	Normality of Aq. HNO <sub>3</sub> .	Per cent Conc. of Aq. HNO <sub>3</sub> .	d <sub>m</sub> of Sat. Sol.	Gms. Ag <sub>2</sub> SO <sub>4</sub> per Liter.
0	0	1.0054	8.35	4.209	23.33	1.1956	73.212
1.0046	6.154	1.061	34.086	5.564	29.84	1.2456	84.609
2.0452	12.005	1.1069	49.010	8.487	42.37	1.3326	94.671
4.017	22.37	1.1871	71.166	10.034	48.77	1.3676	90.806

## SOLUBILITY OF SILVER SULFATE IN AQUEOUS SOLUTIONS OF ACIDS AND SALTS AT 25°.

(Swan, 1899.)

Acid or Salt.	Gm. Equiv. per Liter.	Gms. Dissolved Ag <sub>2</sub> SO <sub>4</sub> per Liter.	Acid or Salt.	Gm. Equiv. per Liter.	Gms. Dissolved Ag <sub>2</sub> SO <sub>4</sub> per Liter.
HNO <sub>3</sub>	0	8.41	H <sub>2</sub> SO <sub>4</sub>	0	8.41
"	0.01589	9.33	"	0.02902	8.55
"	0.03178	10.18	"	0.05802	8.68
"	0.06357	11.83	"	0.10526	8.86
KHSO <sub>4</sub>	0.05264	8.13	K <sub>2</sub> SO <sub>4</sub>	0.02718	7.93
"	0.10526	8.07	"	0.05434	7.68

## SOLUBILITY OF SILVER SULFATE IN AQUEOUS SOLUTIONS OF SALTS AT 25°.

(Harkins, 1911.)

Salt.	Gm. Equiv. Salt per Liter.	d <sub>m</sub> of Sat. Sol.	Gms. Ag <sub>2</sub> SO <sub>4</sub> per Liter.	Salt.	Gm. Equiv. Salt per Liter.	d <sub>m</sub> of Sat. Sol.	Gms. Ag <sub>2</sub> SO <sub>4</sub> per Liter.
KNO <sub>3</sub>	0	...	8.344	AgNO <sub>3</sub>	0.09961	1.0137	2.644
"	0.024914	1.0072	8.996	K <sub>2</sub> SO <sub>4</sub>	0.025024	1.0064	7.899
"	0.049774	1.0092	9.531	"	0.050044	1.0079	7.694
"	0.09987	1.0034	10.435	"	0.100	1.0112	7.49
Mg(NO <sub>3</sub> ) <sub>2</sub>	0.024764	1.0073	9.267	"	0.20003	1.0180	7.531
"	0.049595	1.0094	10.029	MgSO <sub>4</sub>	0.020022	1.0061	8.140
"	0.09946	1.0133	11.334	"	0.050069	1.0079	7.941
AgNO <sub>3</sub>	0.024961	1.0065	6.095	"	0.10004	1.0105	7.740
"	0.04986	1.0084	4.487	"	0.20005	1.0164	7.733

One liter of aqueous solution in contact with a mixture of silver sulfate and silver acetate contains 3.95 gms. Ag<sub>2</sub>SO<sub>4</sub> + 8.30 gms. CH<sub>3</sub>COOAg at 17°. Sp. Gr. of solution = 1.0094. (Euler, 1904.)



USEABILITY OF SILVER SULFATE AT 25° IN AQUEOUS SOLUTIONS OF:  
(Drucker, 1901.)

Sulfuric Acid.			Potassium Sulfate.			
per Liter.	Gms. per Liter.		Mols. per Liter.		Gms. per Liter.	
H <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .	H <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .	K <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .	K <sub>2</sub> SO <sub>4</sub> .
0.02	8.11	0.98	0.0246	0.02	7.67	1.74
0.04	8.23	1.96	0.0236	0.04	7.36	3.49
0.10	8.45	4.90	0.0231	0.10	7.20	8.72
0.20	8.58	9.81	0.0232	0.20	7.24	17.44

ITY OF SILVER SULFATE IN AQUEOUS POTASSIUM SULFATE SOLUTIONS.  
(Barre, 1911.)

at 33°.	Results at 51°.		Results at 75°.		Results at 100°.	
100 Gms. Sol.	Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.	
Ag <sub>2</sub> SO <sub>4</sub> .	K <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .	K <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .	K <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .
0.863	3.20	1.023	3.12	1.273	3.23	1.488
0.940	5.61	1.127	5.73	1.406	5.60	1.675
1.046	8.40	1.247	8.43	1.554	8.45	1.890
1.117	10.55	1.340	10.55	1.665	11.30	2.115
1.177	13.16	1.450	13.17	1.806	15.07	2.410
	14.37	1.524	17.06	2.021	18.58	2.677

s at 14.5° are also given.

ITY OF SILVER SULFATE IN AQUEOUS SODIUM SULFATE SOLUTIONS.  
(Barre, 1910, 1911.)

at 33°.	Results at 51°.		Results at 75°.		Results at 100°.	
100 Gms. Sol.	Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.	
Ag <sub>2</sub> SO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	Ag <sub>2</sub> SO <sub>4</sub> .
0.861	0.25	1.032	0.20	1.215	0.50	1.341
0.816	1.02	0.995	0.98	1.210	1.01	1.363
0.832	1.90	1.017	1.06	1.238	1.94	1.418
0.867	2.92	1.053	2.98	1.296	3.02	1.494
0.972	5.40	1.173	5.37	1.458	5.33	1.651
1.150	10.11	1.379	9.81	1.697	10.15	2.012
1.448	20.25	1.705	19.08	2.075	25.45	2.351
1.570	29.23	1.802	29.66	2.138	34.72	2.012
1.462	39.30	1.540	38.94	1.603	38.63	1.687
0.932	44.46	0.882	41.36	1.156	40.16	1.158

s at 14.5° and at 18° are also given.

TY IN SILVER SULFATE IN AQUEOUS 0.5% SOLUTIONS OF VARIOUS COMPOUNDS AT 25°.  
(Rothmund, 1910.)

5% solution of:	Gms. Dissolved Ag <sub>2</sub> SO <sub>4</sub> per Liter.	Aq. 0.5% Solution of:	Gms. Dissolved Ag <sub>2</sub> SO <sub>4</sub> per Liter.	Aq. 0.5% Solution of:	Gms. Dissolved Ag <sub>2</sub> SO <sub>4</sub> per Liter.
Alcohol	7.764	Glycerol	8.202	Acetonitrile	16.37
cohol	7.109	Mannitol	9.262	Glycocol	13.50
lcohol	6.798	Grape Sugar	8.418	Acetic Acid	7.857
c. (tert.)	6.36	Urea	9.448	Phenol	11.81
	6.86	Dimethylpyrone	6.736	Chloral	7.266
	6.424	Urethan	7.078	Methylal	6.393
hyde	7.078	Formamide	8.42	Methyl Acetate	6.61
	8.076	Acetamide	7.794		

-point data for Ag<sub>2</sub>SO<sub>4</sub> + Na<sub>2</sub>SO<sub>4</sub> are given by Nacken (1907).



**SILVER SULFIDE**

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**SILVER SULFIDE**  $\text{Ag}_2\text{S}$ .

One liter  $\text{H}_2\text{O}$  dissolves about  $4 \cdot 10^{-11}$  gm. atoms Ag as sulfide at about  $18^\circ$ .  
(Bernfeld, 1895.)

One liter  $\text{H}_2\text{O}$  dissolves  $0.55 \cdot 10^{-8}$  gm. mols. =  $0.0001363$  gm.  $\text{Ag}_2\text{S}$  at  $18^\circ$ .  
(Weigel, 1907.)

Fusion-point data for  $\text{Ag}_2\text{S} + \text{ZnS}$  are given by Friedrich (1908).

**SILVER SULFONATES****SOLUBILITY IN WATER AT  $20^\circ$ .**

(Sandquist, 1912.)

Sulfonate.	Gms. Sulfonate per 100 Gms. $\text{H}_2\text{O}$ .
Silver .2 Phenanthrene Monosulfonate]	0.099
" .3 " "	0.20
" .10 " "	0.52

**SILVER TARTRATE**  $\text{C}_4\text{H}_4\text{O}_6\text{Ag}_2$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 0.2012 gm.  $\text{C}_4\text{H}_4\text{O}_6\text{Ag}_2$  at  $18^\circ$ , and 0.2031 gm. at  $25^\circ$ .  
(Partheil and Hübner, 1903.)

**SILVER THIOCYANATE**  $\text{AgSCN}$ .**SOLUBILITY IN WATER.**

t°.	Gm. $\text{AgSCN}$ per Liter.	Authority.
20	0.00014	(Böttger, 1903.)
21	0.00025	(Whitby, 1910. See Note, p. 608.)
25	0.00017	(Küster and Thiel, 1903.)
25	0.0002	(Abegg and Cox, 1903.)
100	0.0064	(Böttger, 1906.)

Additional data for the solubility of  $\text{AgSCN}$  in water are given by Kirschner (1912.)

**SOLUBILITY OF SILVER THIOCYANATE IN AQUEOUS POTASSIUM THIOCYANATE AT  $25^\circ$ .** (Hellwig, 1900.)

Mols. KSCN per Liter.	Mols. $\text{AgSCN}$ per Liter.	Gms. $\text{AgSCN}$ per Liter.	Mols. KSCN per Liter.	Mols. $\text{AgSCN}$ per Liter.	Gms. $\text{AgSCN}$ per Liter.
0.573	0.0124	2.06	1.12	0.0975	16.18
0.626	0.0168	2.08	1.20	0.120	19.93
1.066	0.0850	14.01	1.25	0.134	22.34

One liter of aqueous 3 %  $\text{AgNO}_3$  dissolves 0.0432 gm.  $\text{AgSCN}$  at  $25.2^\circ$ . (Hellwig, 1900.)

**SILVER VALERATES**  $\text{AgC}_5\text{H}_9\text{O}_2$ .

Normal Valerate,  $\text{CH}_3(\text{CH}_2)_3\text{COOAg}$ . Iso Valerate,  $\text{CH}_3\text{CH}(\text{CH}_3)_2\text{CH}_2\text{COOAg}$ .

**SOLUBILITY OF EACH SEPARATELY IN WATER.**

(Fürth, 1888; Sedlitzky, 1887.)

t°.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .		t°.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .	
	Normal V.	Iso V.		Normal V.	Iso V.
0	0.229	0.177	50	0.474	0.360
10	0.259	0.211	60	0.552	0.401
20	0.300	0.246	70	0.636	0.443
30	0.349	0.283	80	...	0.486
40	0.408	0.321			

100 gms.  $\text{H}_2\text{O}$  dissolve 0.73 gm. silver valerate at  $20^\circ$ .

100 cc. sat. aq. solution contains 0.71 gm. dextro silver valerate at  $15^\circ$ .  
(Markwald, 1899.)

(Tavarn, 1900.)



**SOLUBILITY OF SILVER VALERATE IN AQUEOUS SOLUTIONS OF SILVER ACETATE, SILVER NITRATE AND OF SODIUM VALERATE.**  
(Arrhenius, 1893.)

In Silver Acetate at 17.8°.				In Silver Nitrate at 16.5°.			
Mols. per Liter.		Gms. per Liter.		Mols. per Liter.		Gms. per Liter.	
$\text{O}_2\text{Ag.}$	$\text{C}_5\text{H}_9\text{O}_2\text{Ag.}$	$\text{C}_5\text{H}_9\text{O}_2\text{Ag.}$	$\text{C}_5\text{H}_9\text{O}_2\text{Ag.}$	$\text{AgNO}_3$	$\text{C}_5\text{H}_9\text{O}_2\text{Ag.}$	$\text{AgNO}_3$	$\text{C}_5\text{H}_9\text{O}_2\text{Ag.}$
0.0067	0.0094	0	1.96	0	0.0094	0	1.96
0.0135	0.0070	1.13	1.46	0.0067	0.0068	1.14	1.42
0.0270	0.0057	2.27	1.19	0.0133	0.0051	2.29	1.07
0.0505	0.0037	4.54	0.77	0.0267	0.0031	4.58	0.65
	0.00265	8.48	0.55	0.1000	0.0012	17.	0.25

In Sodium Valerate at 18.6°.			
Mols. per Liter.		Gms. per Liter.	
$\text{C}_5\text{H}_9\text{O}_2\text{Na.}$	$\text{C}_5\text{H}_9\text{O}_2\text{Ag.}$	$\text{C}_5\text{H}_9\text{O}_2\text{Na.}$	$\text{C}_5\text{H}_9\text{O}_2\text{Ag.}$
0	0.0095	0	1.986
0.0175	0.0047	2.17	0.982
0.0349	0.0030	4.32	0.627
0.0698	0.0018	8.65	0.376
0.1395	0.0015	17.31	0.313

**SILVER VANADATE  $\text{Ag}_2\text{V}_2\text{O}_7$ .**

One liter of aqueous solution contains 0.047 gm. at 14°, and 0.073 gm. at 100°.  
(Carmelly, 1873.)

**SODIUM Na.**

**SOLUBILITY IN LIQUID AMMONIA.**  
(Ruff and Geisel, 1906.)

t°.	Mols. $\text{NH}_3$ Required to Dissolve 1 Gm. Atom Na.	t°.	Mols. $\text{NH}_3$ Required to Dissolve 1 Gm. Atom Na.
-105	4.98	-30	5.52
-70	5.20	0	5.87
-50	5.39	+22	6.14

**SOLUBILITY OF SODIUM IN MELTED SODIUM HYDROXIDE.**  
(von Hevesy, 1909.)

t°.	480°	600°	610°	670°	760°	800°
g. Na per 100 Gms. NaOH	25.3	10.1	9.9	9.5	7.9	6.9

Saturation could not be reached at temperatures below 480°. The saturated solutions were cooled by plunging the container in water and the solidified contents analyzed.

**SOLUBILITY OF SODIUM IN MELTED SODIUM HYDROXIDE CONTAINING OTHER METALS AT 480°.**  
(von Hevesy, 1909.)

* Added Metal.	Gms. Added Metal per 100 Gms. NaOH.	Gms. Dissolved Na per 100 Gms. Solvent.	Added Metal.	Gms. Added Metal per 100 Gms. NaOH.	Gms. Dissolved Na per 100 Gms. Solvent.
Thallium	5.40	23.13	Cadmium	2.87	24.34
"	8.30	23.54	"	3.16	24.29
"	12.42	21.29	Gold	6.03	23.92
"	31.37	20.91	"	8.22	23.39
			Zinc	30.37	25.38

**AMMONIUM  $\text{Na}_2(\text{NH}_4)_2$ .**

100 gms. liquid ammonia dissolve 60.5 gms.  $\text{Na}_2(\text{NH}_4)_2$  at -23°, 56.4 gms. at 56 gms. at +5° and 55 gms. at 9°.  
(Joannia, 1906.)



## SODIUM ACETATE

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SODIUM ACETATE  $\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$ .SOLUBILITY IN WATER.  
(Green, 1908.)

t°.	Gms. $\text{CH}_3\text{COONa}$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{CH}_3\text{COONa}$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
-10	19	Ice	20	123.5	$\text{CH}_3\text{COONa}$ (unstable)
-18	30.4	"	30	126	" "
-10	33	$\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$	40	129.5	" "
0	36.3	"	50	134	"
+10	40.8	"	60	139.5	"
20	46.5	"	70	146	"
30	54.5	"	80	153	"
40	65.5	"	90	161	"
50	83	"	100	170	"
58	138	"	110	180	"
0	119	$\text{CH}_3\text{COONa}$ (unstable)	120	191	"
10	121	" "	123 b. pt.	193	"

Results differing somewhat from the above are given by Köhler (1897); Enklaar (1901) and Schiavor (1902).

SOLUBILITY OF SODIUM ACETATE IN AQUEOUS SOLUTIONS OF ACETIC ACID AT  
VARIOUS TEMPERATURES.  
(Dunningham, 1912.)

Results at 0°.		Results at 15°.		Results at 30°.		Results at 75°.		Solid Phase in Each Case.
Gms. per 100 Gms. Sat. Solution.	$\text{Na}_2\text{O} \cdot (\text{CH}_3\text{CO})_2\text{O}$ .	Gms. per 100 Gms. Sat. Solution.	$\text{Na}_2\text{O} \cdot (\text{CH}_3\text{CO})_2\text{O}$ .	Gms. per 100 Gms. Sat. Solution.	$\text{Na}_2\text{O} \cdot (\text{CH}_3\text{CO})_2\text{O}$ .	Gms. per 100 Gms. Sat. Solution.	$\text{Na}_2\text{O} \cdot (\text{CH}_3\text{CO})_2\text{O}$ .	
...	...	29.34	0.15	35.31	0.77	44.45	0.76	$\text{CH}_3\text{COONa}$
...	...	...	...	26.25	8.92	32.47	5.03	"
...	...	...	...	...	...	22.30	36.69	"
24.12	2.04	25.94	4.19	25.98	9.06	...	...	$\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$
14.46	8.55	15.49	12.01	18.09	13.62	...	...	"
9.72	31	11.45	23.54	13.53	21.88	...	...	"
9.77	41.23	11.25	34.56	13.24	33.05	...	...	" +1.1
9.04	43.94	10.33	39.08	13.14	32.90	17.85	43.06	1.1
...	...	10.22	39.73	7.64	65.07	11.05	65.71	"
...	...	9.16	49.32	...	...	7.63	81.49	"
...	...	...	...	...	...	0.44	98.35	"
8.96	44.80	8.56	54.34	7.67	66.42	...	...	" +1.2
8.72	45.10	7.06	61.63	7.33	69.68	...	...	1.2
7.83	50.03	5.95	70.55	6.61	72.85	...	...	"
6.19	62.44	4.84	77.60	5.52	77.76	...	...	"
4.02	79.29	2.87	86.61	3.78	83.92	...	...	"
1.05	92.29	1.02	95.87	2.94	86.73	...	...	"
0.42	97.51	0.79	98.09	1.27	94.78	...	...	"

1.1 =  $\text{CH}_3\text{COONa} \cdot \text{CH}_3\text{COOH}$ . 1.2 =  $\text{CH}_3\text{COONa} \cdot 2\text{CH}_3\text{COOH}$ .

Additional data for 5°, 20°, 45° and 60° are also given.

Similar data for 30° are given by Dukelski (1909), and for 20° by Abe (1911-12). One determination at 25°, expressed in terms of volume of solution, is given by Herz (1911-12). Two determinations at 10° similarly expressed, are given by Enklaar (1901).

Data for the freezing-point of mixtures of sodium acetate and acetic acid are given by Vasilev (1909).



STABILITY OF SODIUM ACETATE IN AQUEOUS ETHYL ALCOHOL AT 25°.  
(Seidell, 1910.)

cent l in d.	$d_{25}$ of Sat. Sol.	Gms. $\text{CH}_3\text{COO-}$ $\text{Na}_3\text{H}_2\text{O}$ per 100 Gms. Sat. Sol.	Wt. Per cent $\text{C}_2\text{H}_5\text{OH}$ in Solvent.	$d_{25}$ of Sat. Sol.	Gms. $\text{CH}_3\text{COO-}$ $\text{Na}_3\text{H}_2\text{O}$ per 100 Gms. Sat. Sol.
	1.209	55.7	60	0.990	30.4
	1.160	53	70	0.942	22.8
	1.135	49.8	80	0.882	13
	1.108	46.5	90	0.838	6.7
	1.072	42	95	0.828	6.1
	1.038	37	100	0.823	7.3

solid phase in contact with the solution was  $\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$  in all  
ms. absolute alcohol dissolve 7.49 gms.  $\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$  at room temp.  
(Böttker, 1897.)

SOLUBILITY OF SODIUM ACETATE IN AQUEOUS ALCOHOL:

At 18°. (Gerardin, 1865.)			At Different Temperatures. (Schiavor, 1902.)		
t	Gms. $\text{CH}_3\text{COONa}$ per 100 Gms. Aq. Alcohol.	t°.	Degree of Alcohol.	Gms. per 100 Gms. Alcohol.	
				$\text{CH}_3\text{COONa}$ .	$\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$ .
	38	8	98.4	2.08	3.45
	35.9	12	98.4	2.12	3.51
	29.8	19	98.4	2.33	3.86
	27.5	11	90	2.07	3.42
	23.5	13	90	2.13	3.52
	20.4	15	63	13.46	22.32
	14.6	18	63	13.88	23.03
	3.9	21	63	14.65	24.30
	2.1	23	40	28.50	47.27

ms.  $\text{H}_2\text{O}$  dissolve 237.6 gms. sugar + 57.3 gms.  $\text{CH}_3\text{COONa}$ , or 100  
the saturated solution contain 58.93 gms. sugar + 14.44 gms.  $\text{CH}_3\text{COONa}$   
(Köhler, 1897.)

ms. anhydrous hydrazine dissolve 6 gms. sodium acetate at room temp.  
(Welsh and Broderick, 1915.)

ms. propyl alcohol dissolve 0.97 gm. sodium acetate.  
(Schlamp, 1894.)

**M** SulfoANTIMONATE  $\text{Na}_3\text{SbS}_4 \cdot 9\text{H}_2\text{O}$ .

SOLUBILITY IN WATER  
(Donk, 1908.)

Gms. $\text{Na}_3\text{SbS}_4$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{Na}_3\text{SbS}_4$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{Na}_3\text{SbS}_4$ per 100 Gms. Sat. Sol.	Solid Phase.
0.5	Ice	-1.75	11.2	Ice	49.6	38.9	$\text{Na}_3\text{SbS}_4 \cdot 9\text{H}_2\text{O}$
4	"	0	11.8	$\text{Na}_3\text{SbS}_4 \cdot 9\text{H}_2\text{O}$	59.6	45	"
5.7	"	15	19.3	"	69.6	50.7	"
7.8	"	30	27.1	"	79.5	57.1	"
9.2	"	38	32	"			

SOLUBILITY OF SODIUM SULFOANTIMONATE IN AQUEOUS SOLUTIONS OF SODIUM  
HYDROXIDE AT 30°.

(Donk, 1908.)

100 Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{NaOH}$ .		$\text{Na}_3\text{SbS}_4$ .	$\text{NaOH}$ .	
0	$\text{Na}_3\text{SbS}_4 \cdot 9\text{H}_2\text{O}$	16.4	42.6	$\text{Na}_3\text{SbS}_4 \cdot 9\text{H}_2\text{O}$
9.9	"	17.7	47.2	" + $\text{NaOH} \cdot \text{H}_2\text{O}$
24.8	"	9.1	49.5	$\text{NaOH} \cdot \text{H}_2\text{O}$
32.9	"	0	54.3	



# SODIUM SulfoANTIMONATE 628

## SOLUBILITY OF SODIUM SULFOANTIMONATE IN AQUEOUS SOLUTIONS OF SODIUM THIOSULFATE.

(Donk, 1908.)

Results at 0°.			Results at 30°.		
Gms. per 100	Gms. Sat. Sol.	Solid Phase.	Gms. per 100	Gms. Sat. Sol.	Solid Phase.
$\text{Na}_2\text{SbS}_4$ .	$\text{Na}_2\text{S}_2\text{O}_3$ .		$\text{Na}_2\text{SbS}_4$ .	$\text{Na}_2\text{S}_2\text{O}_3$ .	
11.8	0	$\text{Na}_2\text{SbS}_4 \cdot 9\text{H}_2\text{O}$	19.9	7.7	$\text{Na}_2\text{SbS}_4 \cdot 9\text{H}_2\text{O}$
4.4	4.9	"	12.5	16.4	"
0.8	14.6	"	4.2	37.7	"
0.1	27.3	"	1	43.8	"
0	33.6	" + $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$	1	47	"
0	33.6	$\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$	1	47.8	" + $\text{Na}_2\text{SO}_3 \cdot \text{H}_2\text{O}$
			0	45.8	$\text{Na}_2\text{S}_2\text{O}_3 \cdot \text{H}_2\text{O}$

## SOLUBILITY OF SODIUM SULFOANTIMONATE IN AQUEOUS ETHYL ALCOHOL.

(Donk, 1908.)

Results at 0°.		Results at 30°.		Results at 65°.	
Gms. per 100	Gms. Sat. Sol.	Gms. per 100	Gms. Sat. Sol.	Gms. per 100	Gms. Sat. Sol.
$\text{Na}_2\text{SbS}_4$ .	$\text{C}_2\text{H}_5\text{OH}$ .	$\text{Na}_2\text{SbS}_4$ .	$\text{C}_2\text{H}_5\text{OH}$ .	$\text{Na}_2\text{SbS}_4$ .	$\text{C}_2\text{H}_5\text{OH}$ .
11.8	0	19.3	5	47.9	0
8.2	3.7	14.6	10.3	39.3	4.7
3.2	12.7	6.4	24.8	36.5	8 <sup>a</sup>
0.9	29	1.2	46	4.1	54.1 <sup>a</sup>
0	60.8	0	76.2	0	81

\* Two liquid layers separate between these concentrations of alcohol. The composition of some of these conjoined layers is as follows:

Gms. per 100 Gms. Alcoholic Layer.		Gms. per 100 Gms. Aqueous Layer.	
$\text{Na}_2\text{SbS}_4$ .	$\text{C}_2\text{H}_5\text{OH}$ .	$\text{Na}_2\text{SbS}_4$ .	$\text{C}_2\text{H}_5\text{OH}$ .
4.1	54.1	36.5	8
10.2	40.4	27.8	14.3
14.1	33.5	24.1	18.8
...	0	18	27.2

The solid phase in contact with each of the above solutions is  $\text{Na}_2\text{SbS}_4 \cdot 9\text{H}_2\text{O}$ .

## SOLUBILITY OF SODIUM SULFOANTIMONATE IN AQUEOUS METHYL ALCOHOL

(Donk, 1908.)

Results at 0°.			Results at 30°.		
Gms. per 100	Gms. Sat. Sol.	Solid Phase.	Gms. per 100	Gms. Sat. Sol.	Solid Phase.
$\text{Na}_2\text{SbS}_4$ .	$\text{CH}_3\text{OH}$ .		$\text{Na}_2\text{SbS}_4$ .	$\text{CH}_3\text{OH}$ .	
8.6	3.4	$\text{Na}_2\text{SbS}_4 \cdot 9\text{H}_2\text{O}$	27.1	0	$\text{Na}_2\text{SbS}_4 \cdot 9\text{H}_2\text{O}$
2.8	15.5	"	12.8	18.1	"
2.1	23.1	"	5.8	33.1	"
0.3	50.3	"	0.1	65.7	"
0.1	57	"	0.1	84.2	"
0.05	81.7	"	1.2	91.2	"
0.2	92	"	3.9	94	"
2	95.9	"			

## SODIUM ARSENATE $\text{Na}_2\text{AsO}_4 \cdot 12\text{H}_2\text{O}$ .

100 gms. aqueous solution contain 21.1 gms.  $\text{Na}_2\text{AsO}_4 \cdot 12\text{H}_2\text{O}$  (= 10.4 g  $\text{Na}_2\text{AsO}_4$ ) at 17°. Sp. Gr. of solution = 1.1186. (Schiff, 1888)

100 gms. glycerol dissolve 50 gms. sodium arsenate at 15.5°. (Ossendowski, 1899)



DIAGRAM IN THE SYSTEM SODIUM OXIDE, ARSENIC TRIOXIDE, WATER AT 25°.  
(Schreinemakers and de Baat, 1917.)

Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
$\text{Na}_2\text{O}$ .		$\text{As}_2\text{O}_3$ .	$\text{Na}_2\text{O}$ .
0	$\text{As}_2\text{O}_3$	31.05	21.82
2.45	"	$\pm 29$	$\pm 22.7$
4.23	"	21.92	24.04
6.46	"	17.50	25.64
9.60	"	14.26	29.16
$\pm 12$	" + $\text{NaAsO}_3$	14.63	30.24
12.73	$\text{NaAsO}_3$	19.32	32.04
13.24	"	15.53	33.57
14.27	"	10.49	36.21
18.74	"	6.59	39.39
$\pm 21.1$	" + $\text{Na}_2\text{As}_2\text{O}_7 \cdot 9\text{H}_2\text{O}$	5.11	39.69
21.6	$\text{Na}_2\text{As}_2\text{O}_7 \cdot 9\text{H}_2\text{O}$	0	41.2

I Hydrogen **ARSENATE**  $\text{Na}_2\text{HASO}_4 \cdot 12\text{H}_2\text{O}$ .

SOLUBILITY IN WATER.

Average curve from results of Schiff, 1860; Tilden, 1884; Greenish and Smith, 1901.)

Gms. $\text{Na}_2\text{HASO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{Na}_2\text{HASO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{Na}_2\text{HASO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .
7.3	20	26.5	40	47
15.5	25	33	60	65
20.5 ( $d = 1.1765$ )	30	37	80	85

I Diethyl **BARBITURATE**  $\text{Na}(\text{C}_4\text{H}_{11}\text{O}_2\text{N}_2)$ .

SOLUBILITY IN WATER.

(Puckner and Hilpert, 1909.)

t°.	5°	15°	25°	91°
alt per 100 Gms. Sat. Sol.	6.08	16.87	17.18	32.50

I **BENZOATE**  $\text{C}_6\text{H}_5\text{COONa}$ .

SOLUBILITY IN AQUEOUS ETHYL ALCOHOL AT 25°.

(Seidell, 1910.)

nt	$d_{20}^{\circ}$ of Sat. Sol.	Gms. $\text{C}_6\text{H}_5\text{COONa}$ per 100 Gms. Sat. Sol.	Wt. Per cent $\text{C}_6\text{H}_5\text{OH}$ in Solvent.	$d_{20}^{\circ}$ of Sat. Sol.	Gms. $\text{C}_6\text{H}_5\text{COONa}$ per 100 Gms. Sat. Sol.
1.155		36	60	0.975	21.3
1.132		35.3	70	0.927	15.4
1.110		33.7	80	0.877	8.8
1.086		31.5	90	0.831	2.8
1.055		28.9	95	0.812	1.3
1.020		25.6	100	0.795	0.6

I (Tetra) **BORATE**  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$  (Borax).

SOLUBILITY IN WATER.

(Horn and Van Wagener, 1903.)

Gms. $\text{Na}_2\text{B}_4\text{O}_7$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{Na}_2\text{B}_4\text{O}_7$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{Na}_2\text{B}_4\text{O}_7$ per 100 Gms. $\text{H}_2\text{O}$ .
1.3	50	10.5	60	19.4
1.6	54	13.3	62	22
2.8	55	14.2	65	22
3.9	56	15	70	24.4
5.6	57	16	80	31.5
8.1			90	41
			100	52.5

np.,  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O} \rightarrow \text{Na}_2\text{B}_4\text{O}_7 \cdot 5\text{H}_2\text{O}$ , approximately 62°.

[sat. sol. = 1.020.

(Greenish and Smith, 1901.)

100 gms.  $\text{H}_2\text{O}$  dissolve 3.33 gms.  $\text{Na}_2\text{B}_4\text{O}_7$  at 25°, determined by refractometer.

(Omaka, 1903-08.)



SOLUBILITY OF SODIUM BORATES IN WATER AT 30°.  
(Dukelaki, 1906, complete references given.)

Gms. per 100 Gms. Solution.		Gms. per 100 Gms. Residue.		Solid Phase.
$\text{Na}_2\text{O}$ .	$\text{B}_2\text{O}_3$ .	$\text{Na}_2\text{O}$ .	$\text{B}_2\text{O}_3$ .	
42.0	...	...	...	$\text{NaOH} \cdot \text{H}_2\text{O}$
41.37	5.10	43.54	4.19	"
38.85	5.55	37.20	11.18	$\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$
34.44	3.73	33.52	10.80	"
29.39	2.51	29.63	10.11	"
26.13	2.75	27.85	15.21	"
23.00	3.82	24.91	11.60	"
16.61	13.69	21.29	20.64	"
21.58	4.63	24.52	19.04	$\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot 4\text{H}_2\text{O} + \frac{1}{2}\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot 8\text{H}_2\text{O}$
20.58	4.69	21.61	16.59	$\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot 8\text{H}_2\text{O}$
15.32	6.21	19.70	17.84	"
12.39	9.12	18.05	18.17	"
8.85	10.49	11.72	20.62	$\text{Na}_2\text{O} \cdot 2\text{B}_2\text{O}_3 \cdot 10\text{H}_2\text{O}$
5.81	6.94	10.82	21.31	"
1.88	2.41	7.31	15.50	"
1.38	5.16	7.16	17.44	"
2.02	7.79	6.24	16.38	"
4.08	17.20	8.96	29.20	$\text{Na}_2\text{O} \cdot 2\text{B}_2\text{O}_3 \cdot 10\text{H}_2\text{O} + \text{Na}_2\text{O} \cdot 5\text{B}_2\text{O}_3$
3.79	15.84	5.68	28.19	$\text{Na}_2\text{O} \cdot 5\text{B}_2\text{O}_3 \cdot 10\text{H}_2\text{O}$
2.26	12.14	5.21	29.19	"
1.99	11.84	5.74	39.66	$\text{Na}_2\text{O} \cdot 2\text{B}_2\text{O}_3 \cdot 10\text{H}_2\text{O} + \text{B}(\text{OH})_3$
1.86	11.18	1.06	28.78	$\text{B}(\text{OH})_3$
0.64	6.11	0.31	31.19	"
...	3.54	...	...	"

EQUILIBRIUM IN THE SYSTEM SODIUM OXIDE, BORIC OXIDE, WATER AT  
(Sborgi and Mecacci, 1915, 1916.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
$\text{Na}_2\text{O}$ .	$\text{B}_2\text{O}_3$ .		$\text{Na}_2\text{O}$ .	$\text{B}_2\text{O}_3$ .	
49.25	0	$\text{NaOH} \cdot \text{H}_2\text{O}$	19.29	22.78	$\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$
48.44	0.81	"	20.30	25.50	"
49.28	1.53	" + $2\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot \text{H}_2\text{O}$	22.21	32.17	" + $\text{Na}_2\text{O} \cdot 2\text{B}_2\text{O}_3$
47.38	2.24	$2\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot \text{H}_2\text{O}$	19.43	27.09	$\text{Na}_2\text{O} \cdot 2\text{B}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$
44.74	3.78	"	16.13	23.05	"
42.94	5.67	" + $\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot \text{H}_2\text{O}$	13.51	19.10	"
40.14	5.41	$\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot \text{H}_2\text{O}$	11.58	16.62	"
38.70	5.56	"	6.95	11.50	"
35.76	6.29	"	5.65	14.89	"
34.93	6.80	"	6.84	20.40	"
31.88	9.85	" (unstable)	8.42	28.05	"
29.56	11.83	"	11.29	41.47	" + $\text{Na}_2\text{O} \cdot 5\text{B}_2\text{O}_3$
28.07	14.65	"	8.29	33.57	$\text{Na}_2\text{O} \cdot 5\text{B}_2\text{O}_3 \cdot 10\text{H}_2\text{O}$
33.12	7.47	" + $\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$	6.29	28.77	"
28.64	6.51	$\text{Na}_2\text{O} \cdot \text{B}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$	3.22	21.94	"
22.06	10.29	"	3.40	22.59	" + $\text{H}_2\text{O}$
18.72	17.33	"	1.39	13.92	$\text{H}_3\text{BO}_3$
18.32	19.17	"	0	7.39	"



# BORATES

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## SOLUBILITY OF SODIUM BORATES IN SEVERAL SOLVENTS.

te.	Solvent.	t°.	Gms. Salt per 100 Gms. Solvent.	Authority.
borate	Alcohol ( $d=0.941$ )	15.5	2.48	(U. S. P. VIII.)
"	Glycerol	15.5	60.3	(U. S. P. VIII.)
"	"	80	100	(U. S. P. VIII.)
Biborate	Trichlorethylene	15	0.011	(Wester and Bruins, 1914.)

point data for mixtures of  $\text{NaBO}_2 + \text{NaPO}_3$  and  $\text{NaBO}_2 + \text{Na}_2\text{SiO}_3$  are Van Klooster (1910-11). Results for  $\text{Na}_2\text{B}_4\text{O}_7 + \text{Na}_4\text{P}_2\text{O}_7$  are given by ier (1894).

## BROMATE $\text{NaBrO}_3$ .

### SOLUBILITY IN WATER.

(Kremers, 1855-56a.)

t°.	0°	20°	40°	60°	80°	100°
$\text{NaBrO}_3$ per 100 Gms. $\text{H}_2\text{O}$	27.5	34.5	50.2	62.5	75.7	90.9

of saturated solution at  $19.5^\circ = 1.231$ . (Gerlach.)  
 anhydrous hydrazine dissolve 1 gm.  $\text{NaBrO}_3$  with decomposition. (Welsh and Broderick, 1915.)

## BROMIDE $\text{NaBr} \cdot 2\text{H}_2\text{O}$ .

### SOLUBILITY IN WATER.

Gms. NaBr per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. NaBr per 100 Gms. Sat. Sol.	Solid Phase.
20.8 (1)	Ice	50	53.7 (4)	$\text{NaBr} \cdot 2\text{H}_2\text{O}$
40.3 (2)	" + $\text{NaBr} \cdot 5\text{H}_2\text{O}$	50.7	53.9 (5)	" + $\text{NaBr}$
41.2 (3)	$\text{NaBr} \cdot 5\text{H}_2\text{O} + \text{NaBr} \cdot 2\text{H}_2\text{O}$	80	54.2 (4)	$\text{NaBr}$
41.8 (4)	$\text{NaBr} \cdot 2\text{H}_2\text{O}$	100	54.8 (4)	"
42.9 (4)	"	110	55.1 (4)	"
44.3 (4)	"	140	56.5 (6)	"
47 (8)*	"	180	59.5 (6)	"
47.5 (4)	"	210	60.9 (6)	"
49.4 (7)	"	230	62 (6)	"
51.4 (4)	"			

\* ( $d_{20} = 1.523$ ).

ref (1862); (2) Guthrie (1875); (3) Panfiloff (1893); (4) de Coppet (1883); (5) Richards  
 ll (1899); (6) Etard (1894); (7) Cocheret (1911); (8) Greenish (1900).

## SOLUBILITY OF SODIUM BROMIDE IN AQUEOUS SOLUTIONS OF SODIUM HYDROXIDE AT $17^\circ$ .

(Ditte, 1897.)

per 100 Gms. $\text{H}_2\text{O}$ .		Gms. per 100 Gms. $\text{H}_2\text{O}$ .		Gms. per 100 Gms. $\text{H}_2\text{O}$ .	
OH.	NaBr.	NaOH.	NaBr.	NaOH.	NaBr.
0	91.38	17.17	63.06	28.43	48.00
.26	79.86	19.12	62.51	36.61	38.41
.24	68.85	22.35	59.60	46.96	29.37
.43	64.90	24.74	55.03	54.52	24.76

## SOLUBILITY OF SODIUM BROMIDE IN AQUEOUS ETHYL ALCOHOL AT $30^\circ$ .

(Cocheret, 1911.)

100 Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
NaBr.		$\text{C}_2\text{H}_5\text{OH}$ .	NaBr.
49.4	$\text{NaBr} \cdot 2\text{H}_2\text{O}$	65.51	16.08
42.9	"	72.36	13.41
32.12	"	76.92	12.03
26.79	"	87.35	7.44
20.83	"	97.08	3.01



## SOLUBILITY OF SODIUM BROMIDE IN ALCOHOLIC SOLUTIONS.

(Rohland, 1898-05; de Bruyn, 1892; Eder, 1876.)

Alcohol.	Concentration of Aq. Alcohol.	t°.	Gms. NaBr per 100 Gms. Alcohol.	
Methyl Alcohol	$d_{15}=0.799$	room temp.	21.7	(R.)
Ethyl "	$d_{15}=0.810$	"	7.14	"
Propyl "	$d_{15}=0.816$	"	2.01	"
Ethyl "	90% by vol.	?	4.0	(hydrated NaBr)
Methyl "	Absolute	19.5	17.35	(de Bruyn.)
Ethyl "	"	15	6.3	(NaBr $\cdot$ H <sub>2</sub> O) (Eder.)
Ethyl Ether	"	15	0.08	"

A sat. solution of NaBr in CH<sub>3</sub>OH contains 0.9 gm. NaBr per 100 gms. solution at the critical temperature. (Centnerswer, 1910.)

100 cc. of ethyl alcohol of  $d = 0.8327$  dissolve 7.37 gms. NaBr at 16.4°,  $d_{15}$  of sat. sol. = 0.889. (Greenish, 1900.)

100 gms. propyl alcohol dissolve 2.05 gms. NaBr at ord. temp. (Schlamp, 1894.)

## SOLUBILITY OF SODIUM BROMIDE IN MIXTURES OF ALCOHOLS AT 25°.

(Hetz and Kuhn, 1908.)

In CH <sub>3</sub> OH + C <sub>2</sub> H <sub>5</sub> OH.			In CH <sub>3</sub> OH + C <sub>2</sub> H <sub>5</sub> OH.			In C <sub>2</sub> H <sub>5</sub> OH + C <sub>2</sub> H <sub>5</sub> OH.		
Per cent CH <sub>3</sub> OH in Mixture.	$d_m$ of Sat. Sol.	Gms. NaBr per 100 cc. Sat. Sol.	Per cent C <sub>2</sub> H <sub>5</sub> OH in Mixture.	$d_m$ of Sat. Sol.	Gms. NaBr per 100 cc. Sat. Sol.	Per cent C <sub>2</sub> H <sub>5</sub> OH in Mixture.	$d_m$ of Sat. Sol.	Gms. NaBr per 100 cc. Sat. Sol.
0	0.8189	2.93	0	0.9238	14.40	0	0.8189	2.93
4.37	0.8265	3.65	11.11	0.9048	12.43	8.1	0.8147	2.49
10.4	0.8273	4.04	23.8	0.8887	10.53	17.85	0.8145	2.47
41.02	0.8593	7.24	65.2	0.8390	4.42	56.6	0.8107	1.90
80.69	0.9079	12.51	91.8	0.8153	1.47	88.6	0.8116	1.11
84.77	0.9104	12.86	93.75	0.8144	1.26	91.2	0.8083	0.83
91.25	0.9235	14.32	100	0.8093	0.74	95.2	0.8090	0.82
100	0.9238	14.40				100	0.8093	0.74

## SOLUBILITY OF SODIUM BROMIDE IN ACETAMIDE AT VARIOUS TEMPERATURES.

(Menschutkin, 1908.)

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	$\text{NaBr} \cdot 2\text{CH}_3\text{CONH}_2 = \text{NaBr}$				$\text{NaBr} \cdot 2\text{CH}_3\text{CONH}_2 = \text{NaBr}$		
82*	...	...	$\text{CH}_3\text{CONH}_2$	90	29.4	13.7	$\text{NaBr} \cdot 2\text{CH}_3\text{CONH}_2$
80	6	2.8	"	100	32.2	15	"
78	11.5	5.36	"	110	35.3	16.4	"
76	16.3	7.6	"	120	38.7	18	"
74	20.2	9.4	"	130	42.6	19.8	"
72	23	10.7	"	135†	45.3	21.1	" + NaBr
70‡	25	11.6	" + $\text{NaBr} \cdot 2\text{CH}_3\text{CONH}_2$	155	46.4	21.6	NaBr
80	27	12.6	$\text{NaBr} \cdot 2\text{CH}_3\text{CONH}_2$	175	47.5	22.1	"

\* M. pt.

† Tr. pt.

‡ Eutec.

100 gms. 95% formic acid dissolve 22.3 gms. NaBr at 18.5°. (Aschan, 1915.)

100 cc. anhydrous hydrazine dissolve 37 gms. NaBr at room temp.

(Welsh and Broderson, 1915.)

## FUSION-POINT DATA (Solubilities, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES.

NaBr + NaCl	(Amadori, 1912a; Ruff and Plato, 1903.)
NaBr + NaI	(Amadori, 1912a.)
NaBr + NaF.	(Ruff and Plato, 1903.)
NaBr + NaOH	(Scarpa, 1915.)
NaBr + NaNO <sub>2</sub> .	(Meneghini, 1912.)
NaBr + Na <sub>2</sub> SO <sub>4</sub> .	(Ruff and Plato, 1903.)



**JM CACODYLATE**  $(\text{CH}_3)_3\text{AsO.ONa}$ .

gms.  $\text{H}_2\text{O}$  dissolve about 200 gms. of the salt at  $15^\circ$ – $20^\circ$ . (Squire and Caines, 1905.)  
 x. 90% alcohol dissolve about 100 gms. of the salt at  $15^\circ$ – $20^\circ$ . "

**JM CAMPHORATIS**

**SOLUBILITY IN AQUEOUS *d* CAMPHORIC ACID SOLUTIONS AT  $13.5^\circ$ – $16^\circ$ .**  
 (Jungfleisch and Landrieu, 1914.)

per 100 Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
$\text{C}_{10}\text{H}_{16}\text{O}_4\text{Na}_2$		$\text{C}_{10}\text{H}_{16}\text{O}_4$ $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Na}_2$	
0	$\text{C}_{10}\text{H}_{16}\text{O}_4$	2.87	25.62 $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Na}_2$ $\text{C}_{10}\text{H}_{16}\text{O}_4$ $\cdot 2\text{H}_2\text{O}$
4.19	"	2.89	27.41 "
8.32	"	2.74	30.69 "
10.05	"	2.63	32.75 "
7.80	" + $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Na}_2$ $\cdot 2\text{C}_{10}\text{H}_{16}\text{O}_4$ $\cdot 2\text{H}_2\text{O}$	2.29	40.10 $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Na}_2$ $\cdot \text{H}_2\text{O}$ (or $\frac{1}{2}\text{H}_2\text{O}$ )
9.06	$\text{C}_{10}\text{H}_{16}\text{O}_4\text{Na}_2$ $\cdot 2\text{C}_{10}\text{H}_{16}\text{O}_4$ $\cdot 2\text{H}_2\text{O}$	2.17	40.54 "
10.46	"	1.06	47.04 "
14.99	"	0.88	49.60 $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Na}_2$ $\cdot 3\text{H}_2\text{O}$
17.53	"	0	50.2 "

$\text{C}_{10}\text{H}_{16}\text{O}_4$  = Camphoric acid.  $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Na}_2$   $\cdot 2\text{C}_{10}\text{H}_{16}\text{O}_4$   $\cdot 2\text{H}_2\text{O}$  = Monosodium *d* tri-  
 orate.  $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Na}_2$   $\cdot \text{H}_2\text{O}$  = Monosodium *d* camphorate.  $\text{C}_{10}\text{H}_{16}\text{O}_4\text{Na}_2$   $\cdot 3\text{H}_2\text{O}$   
 odium *d* camphorate (neutral).

mixtures were kept in a cellar at a nearly constant temperature and  
 from time to time. Additional determinations at  $17^\circ$ – $23^\circ$  are also given.)

**UM CARBONATE**  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ .**SOLUBILITY IN WATER.**

(Wells and McAdam, Jr., 1907; Mulder, below  $27^\circ$  and above  $44^\circ$ .)

Gms. $\text{Na}_2\text{CO}_3$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Na}_2\text{CO}_3$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
7	$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$	34.76	48.08	$\text{Na}_2\text{CO}_3 \cdot 7\text{H}_2\text{O}$
9.5	"	35.62	50.08	"
12.5	"	35.50	...	" + $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$
16.4	"	29.86	50.53	$\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$
21.5	"	31.80	50.31	"
34.20	"	35.17	49.63	"
37.40	"	36.45	49.36	"
40.12	"	37.91	49.11	"
43.25	"	41.94	48.51	"
45.64	"	43.94	47.98	"
...	" + $\text{Na}_2\text{CO}_3 \cdot 7\text{H}_2\text{O}$	60	46.4	"
...	" + $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$	80	45.8	"
43.50	$\text{Na}_2\text{CO}_3 \cdot 7\text{H}_2\text{O}$	100	45.5	"
46.28	"	105	45.2	"

determinations of Wells and McAdam, Jr., were made with extreme care.  
 correct the discrepancies which have so far existed between the solubility  
 ransition points of the hydrates. Earlier data, which differ more or  
 om the above, are given by Löwel, 1851; Reich, 1891; Eppel, 1899 and  
 r, 1901–02. Single determinations at  $15^\circ$ ,  $25^\circ$ , and  $30^\circ$  are given by  
 sh and Smith (1901); Osaka (1910–1911); de Paepe (1911) and Cocheret

Gr. of solution saturated at  $17.5^\circ$ , 1.165 (Hager); at  $18^\circ$ , 1.172 (Kohl-  
 ); at  $23^\circ$ , 1.22 (Schiff); at  $30^\circ$ , 1.342 (Lunge). See also Wegscheider  
 alter, 1905, for Sp. Gr. determinations at other temperatures.



## EQUILIBRIUM IN THE SYSTEM SODIUM CARBONATE, SODIUM BICARBONATE AND WATER AT 25°.

(McCoy and Test, 1911.)

(Forty grams of  $\text{NaHCO}_3$  and about 200 cc. of  $\text{H}_2\text{O}$  were rotated at equilibrium was reached. Small portions of the clear solution were analyzed by the Winkler method for carbonate content, and by titration with methyl orange, for sodium. About 15 gms. of  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$  were then added and the mixture again rotated until equilibrium was reached, and again this was continued and the following results were obtained.)

Per cent of Total Na Present as Bicarbonate.	Gms. Na per Liter.	Gms. Bicarbonate per Liter.	Gms. Carbonate per Liter.	Solid Phase
0	119.9	0	276.4	$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$
5.92	127.6	27.6	276.3	" + $\text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3$
7.5	120	...	...	$\text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3$
10	107	...	...	"
12.89	108	50.8	216.6	" + $\text{NaHCO}_3$
15	100	...	...	$\text{NaHCO}_3$
20	80	...	...	"
32	60	...	...	"
56	40	...	...	"
80	30	...	...	"
100	27.02	98.7	0	"

The following data for this system also at 25°, but given in terms of volume of solution, are reported by de Paepe (1911).

Gms. per 100 Gms. $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	Solid Phase.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .	Gms. $\text{H}_2\text{O}$ .	S
$\text{Na}_2\text{CO}_3$ .	$\text{NaHCO}_3$ .		$\text{Na}_2\text{CO}_3$ .	$\text{NaHCO}_3$ .	
28.3	0	$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$	12.4	7.3	
27.3	2.1	"	6.2	9	
26.5	4.2	" + $\text{NaHCO}_3$	1	10.1	
19.2	5.7	$\text{NaHCO}_3$			

## SOLUBILITY OF SODIUM CARBONATE IN AQUEOUS SOLUTIONS OF SODIUM BROMIDE AND OF SODIUM IODIDE AT 30°.

(Cocheret, 1911.)

## In Aq. NaBr Solutions.

Gms. per 100 Gms. Sat. Sol.	Gms. Sat. Sol.	Solid Phase.
$\text{Na}_2\text{CO}_3$ .	NaBr.	
27.98	0	$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$
27.54	2.41	"
26.72	4.06	"
26.23	6.26	" + $\text{Na}_2\text{CO}_3 \cdot 7\text{H}_2\text{O}$
23.40	11	$\text{Na}_2\text{CO}_3 \cdot 7\text{H}_2\text{O}$
22.68	12.22	"
19.86	16.88	"
19.57	16.95	" + $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$
18.11	19.32	$\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$
8.45	33.39	"
6.90	36.13	"
3.04	44.75	"
2.99	45.31	" + $\text{NaBr} \cdot 2\text{H}_2\text{O}$
2.60	45.68	$\text{NaBr} \cdot 2\text{H}_2\text{O}$
0	49.40	"

## In Aq. NaI Solution

Gms. per 100 Gms. Sat. Sol.	Gms. Sat. Sol.	So
$\text{Na}_2\text{CO}_3$ .	NaI.	
26.5	2.4	$\text{Na}_2\text{CO}_3$
25.5	4.7	"
24.4	8.6	"
24.3	9.5	" + $\text{Na}_2\text{CO}_3$
23	11.2	$\text{Na}_2\text{CO}_3$
20.8	14	"
18.7	18.4	"
15.3	25.4	" + $\text{Na}_2\text{CO}_3$
13.1	29.1	$\text{Na}_2\text{CO}_3$
10.4	33.3	"
4.2	46	"
2.7	51	"
0.9	57.6	"
0.3	65.6	" + $\text{NaI}$
0	65.5	$\text{NaI}$



**SOLUBILITY OF SODIUM CARBONATE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE AT 15°.**

(Reich, 1891.)

Gms. per 100 Gms. H <sub>2</sub> O.		Gms. NaCl per 100 Gms. Solution.	Gms. Na <sub>2</sub> CO <sub>3</sub> per 100 Gms. NaCl Solution.	Gms. per 100 Gms. H <sub>2</sub> O.		Gms. NaCl per 100 Gms. Solution.	Gms. Na <sub>2</sub> CO <sub>3</sub> per 100 Gms. NaCl Solution.
NaCl.	Na <sub>2</sub> CO <sub>3</sub> ·10-H <sub>2</sub> O.			NaCl.	Na <sub>2</sub> CO <sub>3</sub> ·10-H <sub>2</sub> O.		
0	61.42	0	16.42	23.70	39.06	15.96	9.76
4.03	53.86	2.92	14.47	27.93	39.73	18.26	9.62
8.02	48	5.80	12.87	31.65	41.44	20.06	9.73
12.02	43.78	8.61	11.62	35.46	43.77	21.75	7.95
16.05	40.96	11.31	10.70	37.23	45.27*	22.46	10.13
19.82	39.46	13.71	10.11				

\* Both salts in solid phase.

**SOLUBILITY OF SODIUM CARBONATE IN AQUEOUS SODIUM CHLORIDE AT 30°.**

(Cocheret, 1911.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
Na <sub>2</sub> CO <sub>3</sub> .	NaCl.		Na <sub>2</sub> CO <sub>3</sub> .	NaCl.	
27.98	0	Na <sub>2</sub> CO <sub>3</sub> ·10H <sub>2</sub> O	20.72	11.49	Na <sub>2</sub> CO <sub>3</sub> ·H <sub>2</sub> O
27.48	0.90	"	18	14.12	" + NaCl
27.12	3.33	"	14.81	16.26	NaCl
26.82	4.15	" + Na <sub>2</sub> CO <sub>3</sub> ·7H <sub>2</sub> O	9.71	18.76	"
25.59	5.17	Na <sub>2</sub> CO <sub>3</sub> ·7H <sub>2</sub> O	5.65	21.94	"
24.26	5.93	"	0	26.47	"
22.75	10.24	" + Na <sub>2</sub> CO <sub>3</sub> ·H <sub>2</sub> O			

**SOLUBILITY OF SODIUM CARBONATE IN AQUEOUS SOLUTIONS OF SODIUM NITRATE.**

(Kremann and Zitek, 1909.)

t°.	Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.	t°.	Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.
	Na <sub>2</sub> CO <sub>3</sub> .	NaNO <sub>3</sub> .			Na <sub>2</sub> CO <sub>3</sub> .	NaNO <sub>3</sub> .	
10	11.98	0	Na <sub>2</sub> CO <sub>3</sub> ·10H <sub>2</sub> O	24.2	24.63	54.43	Na <sub>2</sub> CO <sub>3</sub> ·7H <sub>2</sub> O
10	8.75	70.48	" + NaNO <sub>3</sub>	24.2	21.8	62.7	" + NaNO <sub>3</sub>
10	0	80.5	NaNO <sub>3</sub>	24.2	5.96	84.45	NaNO <sub>3</sub>
24.2	28.55	0	Na <sub>2</sub> CO <sub>3</sub> ·10H <sub>2</sub> O	24.2	0	91.3	"
24.2	26.33	45.96	" + Na <sub>2</sub> CO <sub>3</sub> ·7H <sub>2</sub> O				

**SOLUBILITY OF SODIUM CARBONATE IN AQUEOUS ETHYL ALCOHOL AT 30°.**

(Cocheret, 1911.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
Na <sub>2</sub> CO <sub>3</sub> .	C <sub>2</sub> H <sub>5</sub> OH.		Na <sub>2</sub> CO <sub>3</sub> .	C <sub>2</sub> H <sub>5</sub> OH.	
26.61	2.64	Na <sub>2</sub> CO <sub>3</sub> ·10H <sub>2</sub> O	0.40	63.20	Na <sub>2</sub> CO <sub>3</sub> ·7H <sub>2</sub> O
26.14	3.41*	"	0.11	73.06	" + Na <sub>2</sub> CO <sub>3</sub> ·H <sub>2</sub> O
1.38	44.81*	"	0.07	78.19	Na <sub>2</sub> CO <sub>3</sub> ·H <sub>2</sub> O
0.62	52.99	"	0.06	90.95	"
0.53	55.70	" + Na <sub>2</sub> CO <sub>3</sub> ·7H <sub>2</sub> O	0.03	95.06	" + Na <sub>2</sub> CO <sub>3</sub>
0.51	56.56	Na <sub>2</sub> CO <sub>3</sub> ·7H <sub>2</sub> O	...	98.46	Na <sub>2</sub> CO <sub>3</sub>

\* Between these two concentrations, the mixtures separate into two liquid layers.

Results are also given for the solubility of Na<sub>2</sub>CO<sub>3</sub> + NaBr and of Na<sub>2</sub>CO<sub>3</sub> + NaCl in Aq. C<sub>2</sub>H<sub>5</sub>OH at 30°.

**SOLUBILITY OF SODIUM CARBONATE IN AQUEOUS SOLUTIONS OF ETHYL AND OF PROPYL ALCOHOL AT 20°.**

(Linebarger, 1892.)

Wt. Per cent Alcohol.	Gms. Na <sub>2</sub> CO <sub>3</sub> per 100 Gms. Sol.		Wt. Per cent Alcohol.	Gms. Na <sub>2</sub> CO <sub>3</sub> per 100 Gms. Sol.	
	In Ethyl.	In Propyl.		In Ethyl.	In Propyl.
28	...	4.4	48	0.9	1.3
38	...	2.7	50	0.84	1.2
44	1.7	1.7	54	0.80	0.9
46	1.13	1.5	62	...	0.4



# SODIUM CARBONATE

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## SOLUBILITY OF SODIUM CARBONATE IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL. (Ketner, 1901-02.)

NOTE. — The mixtures were so made that alcoholic and aqueous layers were formed, and these were brought into equilibrium with the solid phase.

t°.	Gms. per 100 Gms. Alcoholic Layer.			Gms. per 100 Gms. Aq. Layer.			Solid Phase.
	C <sub>2</sub> H <sub>5</sub> OH.	Na <sub>2</sub> CO <sub>3</sub> .	H <sub>2</sub> O.	C <sub>2</sub> H <sub>5</sub> OH.	Na <sub>2</sub> CO <sub>3</sub> .	H <sub>2</sub> O.	
35	62.9	0.3	36.8	1	32.4	66.6	Na <sub>2</sub> CO <sub>3</sub> .H <sub>2</sub> O
40	61	0.4	38.6	1.2	31.9	66.9	"
49	61	0.4	38.6	1.2	31.5	67.3	"
68	55.8	0.9	43.3	2.3	28.8	68.9	"
31.2	52.4	0.8	46.8	...	29.3	...	Na <sub>2</sub> CO <sub>3</sub> .H <sub>2</sub> O (H)
31.9	54.8	0.7	44.5	1.7	29.8	68.5	"
32.3	56.1	0.6	43.3	1.5	30.2	68.3	"
33.2	58.1	0.5	42.4	1.4	31	67.6	"
27.7	Crit. sol. $\pm 14\%$ C <sub>2</sub> H <sub>5</sub> OH $\pm 13\%$ Na <sub>2</sub> CO <sub>3</sub> $\pm 73\%$ H <sub>2</sub> O						
28.2	23.5	7.3	69.2	7.9	18.6	73.5	Na <sub>2</sub> CO <sub>3</sub> .H <sub>2</sub> O
29	32.7	3.8	63.5	4.3	22.7	73.0	"
29.7	40	2.1	57.9	2.9	25.5	71.6	"
30.6	47.8	1.2	51	2.3	27.8	69.9	"

## SOLUBILITY OF Na<sub>2</sub>CO<sub>3</sub>.10H<sub>2</sub>O IN DILUTE ALCOHOL AT 21°. (Ketner.)

Gms. per 100 Gms. Solution.			Gms. per 100 Gms. Solution.		
Na <sub>2</sub> CO <sub>3</sub> .	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	Na <sub>2</sub> CO <sub>3</sub> .	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.
18.5	0	81.5	1.2	39.2	59.6
12.7	6.2	81.1	0.2	58.2	41.6
6.9	15.3	77.8	0.1	67.1	32.8
3.2	26.1	70.7	0.06	73.3	26.64

Isotherms showing the compositions of the conjugated liquids at 28.2°, 29.7° and 40° are also given.

## EQUILIBRIUM IN THE SYSTEM SODIUM CARBONATE, NORMAL PROPYL ALCOHOL AND WATER AT 20°. (Frankforter and Temple, 1915.)

(Note. In this paper the results for the binodal curve are reported in terms of gms. per 100 gms. solvent (water + alcohol), instead of gms. per 100 gms. of the homogeneous liquid (sodium carbonate + water + alcohol.)

Gms. per 100 Gms. Alcohol + Water.			Gms. per 100 Gms. Alcohol + Water.		
Na <sub>2</sub> CO <sub>3</sub> .	Alcohol.	Water.	Na <sub>2</sub> CO <sub>3</sub> .	Alcohol.	Water.
16.568	3.409	96.591	1.990	31.537	68.463
15.363	4.472	95.528	1.338	40.796	59.204
11.696	6.595	93.405	0.930	46.93	53.067
8.415	9.176	90.824	0.567	53.875	46.125
6.660	11.221	88.779	0.298	59.507	40.493
4.138	15.785	84.215	0.160	63.568	36.432
2.878	21.099	78.901	0.109	75.159	24.841

For results on the system sodium carbonate, allyl alcohol, water at 20° see last table, p. 647.

100 gms. glycerol ( $d_{15} = 1.256$ ) dissolve 98.3 gms. Na<sub>2</sub>CO<sub>3</sub> at 15°-16°.

100 gms. saturated solution in glycol contain 3.28-3.4 gms. sodium carbonate.

100 gms. H<sub>2</sub>O dissolve 229.2 gms. sugar + 24.4 gms. Na<sub>2</sub>CO<sub>3</sub>, or 100 gms. sat. aq. solution contain 64.73 gms. sugar + 6.89 gms. Na<sub>2</sub>CO<sub>3</sub> at 31.25°.



## EQUILIBRIUM IN THE SYSTEM SODIUM CARBONATE, PYRIDINE, WATER.

(Limbosch, 1909.)

ry pure materials were used. The boiling-point (cor.) of the pyridine was  $-115.07^{\circ}$ . Increasing amounts of this pyridine were added to aqueous ions of sodium carbonate contained in glass tubes. After the tubes were d they were placed in a bath and the temperature noted at which the liquid ure passed from a homogeneous to an opalescent condition. During the vation, the contents of the tubes were stirred by means of pieces of iron, d with the aid of a magnet on the outside of the tube.

wt	Per cent of Pyridine.	t° of Sat.	Per cent of Na <sub>2</sub> CO <sub>3</sub> .	Per cent of Pyridine.	t° of Sat.	Per cent of Na <sub>2</sub> CO <sub>3</sub> .	Per cent of Pyridine.	t° of Sat.
9	66.2	12	2.50	50	199	6.12	23.5	120
9	66.4	25	2.50	53.3	197	6.12	25.5	132
9	67.7	36	2.50	59.4	173	6.12	28.4	152
9	69.2	44	2.50	69.2	123	6.99	13.8	54.2(40.5)
9	73.5	53	2.50	73.8	110	6.99	15.4	81 (17)
9	74.8	51.5	2.50	74.8	*	6.99	19.5	117
9	76.1	25.5(-64)	3.49	30.3	-0.5	6.99	22.7	142
9	77.8	11 (-59)	3.49	32.6	39	6.99	25.1	158
	47.6	17	3.49	34.3	86.5	6.99	27.6	169
	49.9	36	3.49	36.7	107	6.99	32.6	180+
	51.2	55	3.49	37.4	123	9.36	8.50	64 (26)
	52.2	72	3.49	42.5	194	9.36	9	78 (18)
	56.1	107	3.49	69.6	167	9.36	11.4	106.5
	60.6	111	3.49	71.2	*	9.36	13.8	127
	66.8	110	5.23	23.3	63(27.5)	9.36	16.3	148
	75.1	86.5	5.23	23.7	70(20.5)	9.36	20.1	169
	76.9	71	5.23	24.6	79	9.36	25	180+
	78.1	*	5.23	26.2	96	9.36	50	180+
	36.3	22	5.23	28.7	111	18.1	2.12	48 (18)
	37.9	53.25	5.23	32.5	155	18.1	2.25	66
	39.2	74.5	5.23	36.6	196	18.1	2.70	79
	40	94	5.23	37.2	200+	18.1	4.20	108
	43.6	147	5.23	55.4	*	18.1	5.40	126
	47.6	185				18.1	6.80	155

\* Precipitate of Na<sub>2</sub>CO<sub>3</sub>. Results in parentheses show lower temperatures of saturation.

sion-point data for Na<sub>2</sub>CO<sub>3</sub> + NaCl are given by Le Chatelier (11894) and ur (1911-12). Results for Na<sub>2</sub>CO<sub>3</sub> + Na<sub>2</sub>SO<sub>4</sub> are given by Le Chatelier ), Sackur (1911-12) and by Amadori (1912). Results for Na<sub>2</sub>CO<sub>3</sub> + KCl iven by Sackur (1911-12).

IUM (Bi) CARBONATE NaHCO<sub>3</sub>.

## SOLUBILITY IN WATER.

(Dibbits, 1874; Fedotieff, 1904.)

t°.	Gms. NaHCO <sub>3</sub> per 100 Gms.		t°.	Gms. NaHCO per 100 Gms.	
	Water.	Solution.		Water.	Solution.
0	6.9	6.5	30	11.1	10
10	8.15	7.5	40	12.7	11.3
20	9.6	8.8	50	14.45	12.6
25	10.35	9.4	60	16.4	13.8

gms. H<sub>2</sub>O dissolve 9.03 gm. NaHCO<sub>3</sub> at 15°,  $d_{15} = 1.061$ .

gms. alcohol of 0.941 Sp. Gr. dissolve 1.2 gms. NaHCO<sub>3</sub> at 15.5° (Greenish and Smith, 1901.)

gms. glycerol dissolve 8 gms. NaHCO<sub>3</sub> at 15.5°. (Ossendowski, 1907.)



# SODIUM (Bi) CARBONATE

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## SOLUBILITY OF SODIUM BICARBONATE IN AQUEOUS AMMONIUM BICARBONATE SOLUTIONS SATURATED WITH CO<sub>2</sub>.

(Fedotieff, 1904.)

t°.	Wt. of 1 cc. Solution.	Mols. per 1000 Gms. H <sub>2</sub> O.		Grams per 1000 Gms. H <sub>2</sub> O.	
		NH <sub>4</sub> HCO <sub>3</sub> .	NaHCO <sub>3</sub> .	NH <sub>4</sub> HCO <sub>3</sub> .	NaHCO <sub>3</sub> .
0	1.072	1.39	0.58	109.4	48.2
"	...	0.0	0.82	0.0	69.0
15	1.056	0.0	1.05	0.0	88.0
"	1.061	0.29	0.95	23.0	80.0
"	1.065	0.56	0.89	44.0	74.6
"	1.073	1.08	0.79	85.7	66.7
"	1.090	2.16	0.71	170.6	59.2
30	...	0.0	1.65	0.0	138.6
"	...	2.91	0.83	230	70.0

## SOLUBILITY OF SODIUM BICARBONATE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE SATURATED WITH CO<sub>2</sub>.

(Fedotieff; see also Reich, 1891.)

t°.	Wt. of 1 cc. Solution.	Mols. per 1000 Gms. H <sub>2</sub> O.		Grams per 1000 Gms. H <sub>2</sub> O.	
		NaCl.	NaHCO <sub>3</sub> .	NaCl.	NaHCO <sub>3</sub> .
0	..	0.0	0.82	0.0	69.0
"	1.208	6.0	0.09	350.1	7.7
15	1.056	0.0	1.05	0.0	88.0
"	1.063	0.52	0.82	30.2	68.6
"	1.073	1.03	0.64	60.1	53.6
"	1.096	2.11	0.41	123.1	34.8
"	1.127	3.20	0.28	187.2	23.0
"	1.158	4.39	0.19	256.9	16.1
"	1.203	6.06	0.12	354.6	10.0
30	1.066	0.0	1.31	0.0	110.2
"	1.079	1.02	0.87	59.9	72.8
"	1.100	2.08	0.56	121.9	47.3
"	1.127	3.18	0.38	186.3	32.0
"	1.156	4.38	0.27	256.0	22.3
"	1.199	6.12	0.17	358.1	13.9
45	1.077	0.0	1.65	0.0	138.6
"	1.086	1.04	1.12	60.7	94.0
"	1.115	2.65	0.62	155.2	52.0
"	1.127	3.24	0.52	189.4	43.4
"	1.155	4.38	0.37	256.1	30.7
"	1.198	6.18	0.23	361.5	19.5

100 gms. alcohol of 0.941 Sp. Gr. dissolve 5.55 gms. sodium sulfocarbonate 15.5°.

## SOLUBILITY OF SODIUM BICARBONATE IN AQUEOUS SODIUM NITRATE SOLUTIONS.

(Fedotieff and Koltunoff, 1914.)

t°.	Sp. Gr. of Sat. Sol.	Gms. per 100 Gms. H <sub>2</sub> O.	
		NaNO <sub>3</sub> .	NaHCO <sub>3</sub> .
0	1.356	72.74	1.41
15	1.183	29.06	3.40
15	1.285	54.56	2.16
15	1.377	83.20	1.57
30	...	95.14	1.80



**III CHLORATE**  $\text{NaClO}_3$ .

## SOLUBILITY IN WATER.

(Carlson, 1910; Le Blanc and Schmandt, 1911; Osaka, 1903-08.)

<i>d</i> of Sat. Sol.	Gms. $\text{NaClO}_3$ per 100 Gms. $\text{H}_2\text{O}$ .	<i>t</i> °.	<i>d</i> of Sat. Sol.	Gms. $\text{NaClO}_3$ per 100 Gms. $\text{H}_2\text{O}$ .
1.380	72	40	1.472	126 (115 Le B. & S.)
1.389	79 (80 Le B. & S.)	50	...	140 (126 " )
...	89 (87 " )	60	1.514	155
1.419	95 (91 " )	70	...	172
1.430	101 (95.7 " )	80	1.559	189
1.44	106 (101 O.)	100	1.604	230
...	113 (105 Le B. & S.)	122 (b. pt.)	1.654	286

Earlier data of Kremers (1856) lie between the values of Carlson and of Le Blanc and Schmandt.

SOLUBILITY OF SODIUM CHLORATE IN AQUEOUS SODIUM CHLORIDE SOLUTIONS  
AT 20°.

(Winteler, 1900.)

<i>r.</i> of Gms.	Gms. per Liter.		Sp. Gr. of Solutions.	Gms. per Liter.	
	$\text{NaCl}$ .	$\text{NaClO}_3$ .		$\text{NaCl}$ .	$\text{NaClO}_3$ .
26	5	668	1.365	175	393
19	25	638	1.345	200	338
12	50	599	1.319	225	271
5	75	559	1.289	250	197
38	100	522	1.256	275	120
39	125	484	1.235	290	78
79	150	442	1.217	300	55

ms.  $\text{H}_2\text{O}$  dissolve 24.4 gms.  $\text{NaCl}$  + 50.75 gms.  $\text{NaClO}_3$  at 12°.

ms.  $\text{H}_2\text{O}$  dissolve 11.5 gms.  $\text{NaCl}$  + 249.6 gms.  $\text{NaClO}_3$  at 122°. (Schlosing, 1871.)

## SOLUBILITY OF SODIUM CHLORATE IN AQUEOUS ETHYL ALCOHOL.

(Carlson, 1910.)

<i>t</i> °.	Gms. $\text{NaClO}_3$ per Liter of Sat. Sol. in Aqueous Alcohol of:		
	50 Per cent.	75 Per cent.	90 Per cent.
20	313.3	110.8	16.1
40	321.8	133.5	22.9
60	326.8	155.8	29
70	...	161.3	...

ms. alcohol of 77 Wt. per cent dissolve 2.9 gms.  $\text{NaClO}_3$  at 16°. (Wittstein.)

ms. alcohol dissolve 1 gm.  $\text{NaClO}_3$  at 25°, and 2.5 gms. at b. pt.

ms. glycerol dissolve 20 gms.  $\text{NaClO}_3$  at 15.5°. (Ossendowski, 1907.)

c. anhydrous hydrazine dissolve 66 gms.  $\text{NaClO}_3$  at room temperature.

(Welsh and Broderson, 1915.)

**M PerCHLORATE**  $\text{NaClO}_4 \cdot \text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Carlson, 1910)

<i>t</i> °.	<i>d</i> of Sat. Solution	Gms. $\text{NaClO}_4$ per 100 cc. Sat. Solution.	Solid Phase.
15	1.666	107.6	$\text{NaClO}_4 \cdot \text{H}_2\text{O}$
50	1.731	123.4	"
143	1.789	141.4	$\text{NaClO}_4$



# SODIUM CHLORIDE

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## SODIUM CHLORIDE NaCl

### SOLUBILITY IN WATER.

(Mulder; de Coppet, 1883; Andrus, 1884; Raupenstrauch, 1885; above 100°, Tilden and Sinton, 1884; Berkeley, 1904; Etard, 1894, gives irregular results.)

t°.	Gms. NaCl per 100 Gms. H <sub>2</sub> O.		Gms. NaCl per 100 g. Sol.	t°.	Gms. NaCl per 100 Gms. H <sub>2</sub> O.		Gms. NaCl per 100 g. Sol.
0	35.7*	35.63†	26.28†	70	37.8*	37.51†	27.27†
10	35.8	35.69	26.29	80	38.4	38.00	27.54
20	36.0	35.82	26.37	90	39.0	38.52†	27.80
25	36.12	35.92	26.43	100	39.8	39.12†	28.12
30	36.3	36.03	26.49	118		39.8	28.46
40	36.6	36.32	26.65	140		42.1	29.63
50	37.0	36.67	26.83	160		43.6	30.37
60	37.3	37.06	27.04	180		44.9	30.98

\* M.; de C.

† A.

‡ B.

The original, very carefully determined figures of Berkeley, are as follows.

t°.	d of Sat. Sol.	Gms. NaCl per 100 Gms. H <sub>2</sub> O.	t°.	d of Sat. Sol.	Gms. NaCl per 100 Gms. H <sub>2</sub> O.
0.35	1.2090	35.75	61.70	1.1823	37.28
15.20	1.2020	35.84	75.65	1.1764	37.82
30.05	1.1956	36.20	90.50	1.1701	38.53
45.40	1.1891	36.60	107 b. pt.	1.1631	39.65

100 gms. H<sub>2</sub>O dissolve 35.99 gms. NaCl at 30°.

(Cocherel, 1911.)

### SOLUBILITY OF SODIUM CHLORIDE IN WATER, DETERMINED BY THE FREEZING-POINT METHOD.

(Matignon, 1909a.)

t°.	Gms. NaCl per 100 Gms. H <sub>2</sub> O.	Solid Phase.	t°.	Gms. NaCl per 100 Gms. H <sub>2</sub> O.	Solid Phase.
-0.4	0.69	Ice (Raoult)	-12.7	20	Ice
-0.8	1.37	" (Bilta)	-16.66	25	"
-2.86	4.9	" (Kahlenberg)	-21.3	30.7	" + NaCl·H <sub>2</sub> O
-3.42	5.85	" (Raoult)	-14	32.5	NaCl·2H <sub>2</sub> O (de Coppet)
-6.6	11	"	-12.25	32.9	" (Matignon)
-9.25	15	"	-6.25	34.22	" (de Coppet)

Data for the influence of pressure on the solubility of sodium chloride in water are given by v. Stackelberg (1896); Cohen, Inouye, and Euwen (1910) and by Sill (1916).

### SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS SOLUTIONS SIMULTANEOUSLY SATURATED WITH OTHER SALTS.

The various papers of J. H. van't Hoff and collaborators, on this subject, have been collected by H. Precht and E. Cohn in a volume entitled "Untersuchungen über die Bildungsverhältnisse die Ozeanischen Salzablagerungen," Leipzig, 1912, p. 374. By far the larger part of the new data in these papers are for solutions simultaneously saturated with three or more salts and are, therefore, beyond the limits of complexity of mixture, set for the present volume. The various systems are described in detail and diagrams are given. A table summarizing much of the data (van't Hoff (1905)) is given on the following page.



LIQUIDITY OF SODIUM CHLORIDE IN AQUEOUS SOLUTIONS SIMULTANEOUSLY SATURATED WITH OTHER SALTS AT 25°.

(van't Hoff, 1905.)

Mols. per 1000 Mols. H <sub>2</sub> O.				Solution Saturated with Respect to NaCl and:
K <sub>2</sub> Cl <sub>3</sub>	MgCl <sub>2</sub>	MgSO <sub>4</sub>	Na <sub>2</sub> SO <sub>4</sub>	
0.5	105	...	...	MgCl <sub>2</sub> .6H <sub>2</sub> O + Carnallite
5.5	70.5	...	...	KCl + Carnallite
20	...	...	4.5	" + Glaserite
10.5	...	...	14.5	Na <sub>2</sub> SO <sub>4</sub> + "
...	...	16.5	3.0	" + Astrakanite
...	7	34	...	MgSO <sub>4</sub> .7H <sub>2</sub> O + Astrakanite
...	67.5	12	...	" + MgSO <sub>4</sub> .6H <sub>2</sub> O
...	79	9.5	...	Kieserite + "
...	101	5	...	" + MgCl <sub>2</sub> .6H <sub>2</sub> O
14	21.5	14	...	KCl + Glaserite + Schönite
14.5	25.5	14.5	...	" + Leonite + "
9.5	47	14.5	...	" + " + Kainite
6	68	5	...	" + Carnallite + "
1	85.5	8	...	Kieserite + Carnallite + Kainite
8	...	16	6	Na <sub>2</sub> SO <sub>4</sub> + Glaserite + Astrakanite
10.5	16.5	18.5	...	Schönite + Glaserite + Astrakanite
10.5	23	19	...	Leonite + Glaserite + Astrakanite
7.5	42	19	...	" + MgSO <sub>4</sub> .7H <sub>2</sub> O + Astrakanite
7.5	45	19.5	...	" + " + Kainite
4	65.5	13	...	MgSO <sub>4</sub> .6H <sub>2</sub> O + " + "
2	77	10	...	MgSO <sub>4</sub> .6H <sub>2</sub> O + Kieserite + "
0.5	100	5	...	Carnallite + MgCl <sub>2</sub> .6H <sub>2</sub> O + "
0.5	105	...	...	MgCl <sub>2</sub> .6H <sub>2</sub> O + Carnallite
5.5	70.5	...	...	KCl + "
...	...	CaCl <sub>2</sub>	...	
...	51.5	90.5	...	MgCl <sub>2</sub> .6H <sub>2</sub> O + Tachhydrite
11	...	146	...	KCl + CaCl <sub>2</sub> .6H <sub>2</sub> O
...	35.5	121.5	...	Tachhydrite + CaCl <sub>2</sub> .6H <sub>2</sub> O
1.5	50.5	90.5	...	MgCl <sub>2</sub> .6H <sub>2</sub> O + Tachhydrite + Carnallite
9.5	5	141.5	...	CaCl <sub>2</sub> .6H <sub>2</sub> O + KCl + Carnallite
2	34.5	121.5	...	CaCl <sub>2</sub> .6H <sub>2</sub> O + Tachhydrite + Carnallite

allite = KMgCl<sub>2</sub>.6H<sub>2</sub>O, Glaserite = K<sub>2</sub>Na(SO<sub>4</sub>)<sub>2</sub>, Astrakanite = Na<sub>2</sub>Mg-  
 4H<sub>2</sub>O, Kieserite = MgSO<sub>4</sub>.H<sub>2</sub>O, Leonite = MgK<sub>2</sub>(SO<sub>4</sub>)<sub>2</sub>.4H<sub>2</sub>O, Schönite =  
 SO<sub>4</sub>)<sub>2</sub>.6H<sub>2</sub>O, Kainite = MgSO<sub>4</sub>.KCl.3H<sub>2</sub>O.

LIQUIDITY OF SODIUM CHLORIDE IN AQUEOUS SOLUTIONS OF AMMONIUM CHLORIDE.  
 (Fedotieff, 1904.)

	Wt. of 1 cc. Solution.	Mols. per 1000 Gms. H <sub>2</sub> O.		Gms. per 1000 Gms. H <sub>2</sub> O.	
		NH <sub>4</sub> Cl.	NaCl.	NH <sub>4</sub> Cl.	NaCl.
0	...	0	6.09	0	356.3
5	1.185	2.73	4.89	146.1	286.4
10	1.200	0	6.12	0	357.6
15	1.191	1.07	5.58	57.3	326.4
20	1.183	2.22	5.13	118.9	300
25	1.176	3.48	4.64	186.4	271.6
30	1.175	3.72	4.55	198.8	266.8
35	...	0	6.16	0	360.3
40	1.166	4.77	4.26	255.4	249
45	...	0	6.24	0	365
50	...	6.02	4	322.1	233.9



# SODIUM CHLORIDE

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## SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS AMMONIA AT 30°.

(Hempel and Tedesco, 1911.)

$d_{20}$ of Sat. Sol.	Gms. per 1000 cc. Sat. Sol.		$d_{20}$ of Sat. Sol.	Gms. per 1000 cc. Sat. Sol.	
	NH <sub>3</sub>	NaCl		NH <sub>3</sub>	NaCl
1.1735	29.535	293.38	1.1406	72.07	283.38
1.1656	40.655	292.5	1.1395	72.715	283.06
1.160	47.26	289.7	1.1301	81.855	277.49
1.1494	60.78	286.5	1.1205	97.49	270.57

Data for equilibrium in the system sodium chloride, arsenic trioxide, water, at 30°, are given by Schreinemakers and deBaat (1915).

## SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID.

(Engel, 1888; Enklaar, 1901.)

At 0°. (Engel.)					At 10°-10.5°. (Enklaar.)				
Mg. Mols. per 10 cc.		Sp. Gr. of Solution.	Gms. per Liter.		Mols. per Liter.		Grams per Liter.		
HCl.	NaCl.		HCl.	NaCl.	HCl.	NaCl.	HCl.	NaCl.	
0.0	54.7	1.207	0.0	32.0	0.0	6.11	0.0	35.77	
1.0	53.5	1.204	0.365	31.3	0.27	5.77	9.84	33.76	
1.85	52.2	1.202	0.674	30.5	0.35	5.67	12.76	33.19	
5.1	48.5	1.196	1.859	28.4	0.43	5.59	15.68	32.71	
9.28	44.0	1.185	3.38	25.7	0.57	5.43	20.78	31.77	
15.05	37.9	1.173	5.49	22.2	0.72	5.28	26.06	30.89	
30.75	23.5	1.141	11.20	13.7	2.60	3.42	94.77	20.01	
56.35	6.1	1.119	20.54	3.6	2.80	3.18	102.1	19.01	
					3.31	2.74	120.6	16.01	

### Results at 0° and at 25°.

(Armstrong and Eyre, 1910-11.)

Gms. HCl per Liter of Solvent.	Gms. NaCl per 100 Gms. Sat. Sol.	
	At 0°.	At 25°.
0	26.35	26.52 ( $d_{25} = 1.2018$ )
9.11	25.30	25.45 ( $d_{25} = 1.1970$ )
18.22	24.15	25.42 ( $d_{25} = 1.1915$ )
36.45	21.93	22.34 ( $d_{25} = 1.1822$ )
182.25	...	7.04 ( $d_{25} = 1.1238$ )

### Results at 25°.

(Herz, 1911-12.)

Mols. per Liter.	
HCl.	NaCl.
0.607	4.850
1.032	4.467
1.590	3.782
2.117	3.297
3.283	2.343

### Results at 30°.

(Schreinemakers, 1909-10.)

Gms. per 100 Gms. Sat. Sol.	
HCl.	NaCl.
0	26.47
6.93	16.16
12.50	9.35
17.35	4.52
35.60	0.11

### Results at 30°. (Masson, 1911.)

$d_{20}$ of Sat. Sol.	Gm. Mols. per Liter.		$d_{20}$ of Sat. Sol.	Gms. Mols. per Liter.	
	HCl.	NaCl.		HCl.	NaCl.
1.2018	0	5.400	1.1427	3.052	2.463
1.1906	0.4575	4.932	1.1289	4.152	1.628
1.1801	0.969	4.386	1.1188	5.950	0.630
1.1633	1.786	3.589	1.1258	7.205	0.268
1.1512	2.412	2.978			

In the case of the results of Masson equilibrium was approached from above and the solutions were kept in a thermostat and shaken occasionally during 2-6 days.

## SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS CALCIUM CHLORIDE SOLUTIONS AT 25°.

(Mills and Wells, 1918.)

$d_{20}$ of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.		$d_{20}$ of Sat. Sol.	Gms. per 100 Gms. Sat. Sol.	
	CaCl <sub>2</sub> .	NaCl.		CaCl <sub>2</sub> .	NaCl.
1.207	1.103	25.30	1.225	9.50	17.55
1.210	2.160	24.32	1.233	11.48	15.91
1.200	3.220	23.37	1.241	17.77	10.54
1.216	5.451	20.43	1.257	21	8.05
1.220	7.398	19.17	1.276	24.58	5.63



**SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS POTASSIUM NITRATE AT 25°**  
(Ritzel, 1911.)

Gms. per 100 cc. Sat. Sol.		Gms. per 100 cc. Sat. Sol.	
KNO <sub>3</sub>	NaCl	KNO <sub>3</sub>	NaCl
0	31.80	12	30.86
4	32.26	16	30.45
8	31.85	20	30.10

Data for the solubility of NaCl in aqueous MgCl<sub>2</sub> solutions are given by Feit and Przibylla (1909.)

**SOLUBILITY OF MIXTURES OF SODIUM CHLORIDE AND OTHER  
SALTS IN WATER, ETC.**

Solvent.	t°.	Gms. per 100 Gms. Solvent.		Authority.
Water	17	26.4	NaCl + 22.1NH <sub>4</sub> Cl*	(Karsten.)
"	17	34.5	" + 4.1BaCl <sub>2</sub>	"
"	?	38.3	" + 29.5 KNO <sub>3</sub>	"
"	25	38.5	" + 41.14 "	(Soch — J. Physic. Ch. 2, 46, '98.)
"	80	39.81	" + 168.8 "	"
Alcohol (40%)	25	15.78	" + 13.74 "	"
Water	20	30.54	" + 13.95 KCl	(Quoted by Euler — Z. physik. Ch. 49, 315, '04.)
"	25	28.90	" + 16.12 "	

\* Sp. Gr. of solution at 17° = 1.179.

**SOLUBILITY OF MIXTURES OF SODIUM CHLORIDE AND POTASSIUM SULFATE  
IN WATER AT VARIOUS TEMPERATURES.**  
(Precht and Wittgen, 1882.)

t°.	Grams per 100 Grams H <sub>2</sub> O.			t°.	Grams per 100 Grams H <sub>2</sub> O.		
	NaCl	K <sub>2</sub> SO <sub>4</sub>	KCl		NaCl	K <sub>2</sub> SO <sub>4</sub>	KCl
10	33.4	8.1	3.2	60	36.4	11.9	2.7
20	34.0	8.9	3.1	70	36.6	12.8	3.2
30	34.6	9.6	2.9	80	36.0	12.3	5.1
40	35.2	10.4	2.8	90	35.9	12.4	7.0
50	35.8	11.1	2.8	100	35.6	12.6	8.8

**SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS SOLUTIONS OF SODIUM  
BICARBONATE SATURATED WITH CO<sub>2</sub>.** (Fedotieff 1904.)

t°.	Wt. of 1 cc. Solution.	Mols. per 1000 Gms. H <sub>2</sub> O.		Gms. per 1000 Gms. H <sub>2</sub> O.	
		NaHCO <sub>3</sub>	NaCl	NaHCO <sub>3</sub>	NaCl
0	...	0	6.09	0	356.3
"	1.208	0.09	6	7.7	350.1
15	1.203	0	6.12	0	357.6
"	1.203	0.12	6.06	10	354.6
30	1.196	0	6.16	0	360.3
"	1.199	0.17	6.12	13.9	358.1
45	1.189	0	6.24	0	365
"	1.198	0.23	6.18	19.5	361.5

**SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS SODIUM HYDROXIDE AT 30°.**  
(Schreinemakers, 1909-10, 1910.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
Na <sub>2</sub> O.	NaCl		Na <sub>2</sub> O.	NaCl	
0	26.47	NaCl	29.31	2.40	NaCl
4.47	21.49	"	37.85	1.12	"
12.22	13.62	"	41.42	0.97	" + NaOH.H <sub>2</sub> O
24.48	4.36	"	±42	0	NaOH.H <sub>2</sub> O



# SODIUM CHLORIDE

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## SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS SODIUM HYDROXIDE SOLUTIONS.

(Engel; Winteler, 1900.)

At 0° (Engel).			At 20° (Winteler).				
Mg. Mols. per 10 cc.		Sp. Gr. of Solutions.	Gms. per Liter.		Gms. per Liter.		Sp. Gr. of Solution.
Na <sub>2</sub> O.	NaCl.		NaOH.	NaCl.	NaOH.	NaCl.	
0	54.7	1.207	0	320	10	308	1.200
4.8	49.38	1.221	38.4	288.9	50	297	1.230
6.73	47.21	1.225	53.8	276.2	100	253	1.250
10.41	42.38	1.236	183.2	247.9	150	213	1.270
14.78	39.55	1.249	118.2	231.4	200	173	1.290
30.50	24.95	1.295	244	146	300	112	1.330
37.88	19.30	1.314	303	112.9	400	61	1.375
53.25	9.41	1.362	426	55	500	30	1.425
					640	18	1.490

## SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS SOLUTIONS OF SODIUM NITRATE AND VICE VERSA.

(Bodländer, 1891; Nicol, 1891; results at 25° by Soch, 1898.)

NaCl in Aqueous NaNO <sub>3</sub> . Results at 15.5° (B.).				NaNO <sub>3</sub> in Aqueous NaCl. Results at 15° (B.).			
Sp. Gr. of Solutions.	Gms. per 100 cc. Sat. Solution.			Sp. Gr. of Solutions.	Gms. per 100 cc. Sat. Solution.		
	NaNO <sub>3</sub> .	H <sub>2</sub> O.	NaCl.		NaCl.	H <sub>2</sub> O.	NaNO <sub>3</sub> .
1.2025	0	88.47	31.78	1.3720	0	74.82	62.38
1.2305	7.53	87.63	27.89	1.3645	4.0	75.69	56.7
1.2580	13.24	86.25	26.31	1.3585	7.24	75.71	52. —
1.2810	21.58	82.66	23.98	1.3530	11.36	76.86	47. —
1.3090	28.18	80.42	22.30	1.3495	15.33	76.96	42. —
1.3345	33.80	79.25	20.40	1.3485	17.81	77.14	39. —
1.3465	37.88*	77.37	19.40*	1.3485	18.97*	77.15	38. —
1.3465	37.64*	77.34	19.67*	1.3485	19.34*	77.49	38. —

## Results at 20° (N.).

Grams per 100 Grams H <sub>2</sub> O.				Grams per 100 Grams H <sub>2</sub> O.			
0	NaNO <sub>3</sub>	35.91	NaCl	0	NaCl	87.65	NaNO <sub>3</sub>
14.17	"	32.82	"	6.5	"	77.34	"
28.33	"	29.78	"	13.0	"	68.50	"
42.50	"	26.91	"	19.5	"	60.49	"
54.63*	"	24.92*	"				

100 gms. H<sub>2</sub>O dissolve 43.66\* gms. NaNO<sub>3</sub> + 26.58\* gms. NaCl at 25°.

100 gms. H<sub>2</sub>O dissolve 121.6\* gms. NaNO<sub>3</sub> + 17.62\* gms. NaCl at 80°.

100 gms. aq. alcohol of 40 wt. per cent dissolve 22.78 gms. NaNO<sub>3</sub> + 10.17 gms NaCl at 25°.

\* Indicates solutions saturated with both salts.



# SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS SOLUTIONS OF SODIUM NITRATE AND VICE VERSA.

(Leather and Mukerji, 1913.)

Results at 30°.				Results at 40°.				Results at 91°.				Solid Phase in Each Case.
No. of L. Sol.	Gms. per 100 Gms. H <sub>2</sub> O.		<i>d<sub>m</sub></i> of Sat. Sol.	Gms. per 100 Gms. H <sub>2</sub> O.		<i>d<sub>m</sub></i> of Sat. Sol.	Gms. per 100 Gms. H <sub>2</sub> O.					
	NaNO <sub>3</sub> .	NaCl.		NaNO <sub>3</sub> .	NaCl.		NaNO <sub>3</sub> .	NaCl.				
202	0	36.3	1.197	0	36.53	1.189	0	38.72	NaCl			
276	24.21	31.16	1.284	27.31	30.53	1.296	37.43	30.21	"			
343	48.15	26.35	1.323	54.82	26.50	1.381	79.65	23.17	"			
379	63.08	23.50	1.409	73.96	21.87	1.487	127.2	17.05	"			
388	63.40	23.40	1.397	74.01	21.71	1.519	141.4	15.93	" + NaNO <sub>3</sub>			
381	67.91	19.69	1.396	75.29	21.61	1.518	141.3	15.83	" NaNO <sub>3</sub>			
394	81.46	9.76	1.410	89.90	10.80	1.504	149.5	9.03	"			
406	95.90	0	1.421	105.2	0	1.521	160.8	0	"			

Results are also given at 20° which agree satisfactorily with those of Nicol. Additional results at 30°, agreeing fairly well with the above, are given by Copparo (1913). Data for the solubility of sodium chloride in dilute solutions of sodium nitrate at 0° and at 25° are given by Armstrong and Eyre (1910-11).

# SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS 7.45 PER CENT SODIUM SULFATE SOLUTIONS.

(Marie and Marquis, 1903.)

t°.	Gms. NaCl per 100 Gms. Sat. Sol.	t°.	Gms. NaCl per 100 Gms. Sat. Sol.
14.8	23.30	27.75	23.525
17.9	23.33	32.18	23.55
25.6	23.485	34.28	23.68

For additional data on this system see sodium sulfate, pp. 669 and 670.

# SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS SOLUTIONS OF ETHYL ALCOHOL.

(Armstrong and Eyre, 1910-11.)

Results at 0°.			Results at 25°.		
Solvent	Gms. C <sub>2</sub> H <sub>5</sub> OH per 100 Gms. H <sub>2</sub> O.	Gms. NaCl per 100 Gms. Sat. Sol.	<i>d<sub>m</sub></i> of Sat. Sol.	Solvent	Gms. NaCl per 100 Gms. Sat. Sol.
	0	26.46	1.202		26.55
	11.51	25.97	1.196	11.51	26.06
	23.03	25.48	1.190	23.03	25.63
	46.06	24.41	1.179	46.06	24.75
	138.18	20.95	1.159	92.12	23.29
			1.1115	230.3	19.35

# SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS ALCOHOL AT 28°.

(Fontein, 1910.)

Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	NaCl.	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	NaCl.
0	73.53	26.47	45.35	45.35	9.3
3.8	71.6	24.6	56.2	37.5	6.3
7.7	69.7	22.6	67.4	28.9	3.7
16.1	64.6	19.3	78.8	19.7	1.5
25.3	58.9	15.8	89.6	10	0.4
35	52.5	12.5			

Results are also given by Fontein showing the solubility of sodium chloride in mixtures of ethyl alcohol, amyl alcohol and water at 28°, both when one liquid is present and when conjugated liquid layers are formed.



# SODIUM CHLORIDE

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## SOLUBILITY OF SODIUM CHLORIDE IN ALCOHOLS.

(At 18.5°, de Bruyn — Z. physik. Ch. 10, 782, '92; Rohland — Z. anorg. Ch. 18, 327, '94)

t°.	Alcohol.	Gms. NaCl per 100 Gms. Alcohol.	t°.	Alcohol	Gms. NaCl per 100 Gms. Alcohol
18.5	Abs. Methyl	1.41	room temp.	Methyl $d_{15}$	= 0.799 1.33
"	" Ethyl	0.065	"	Ethyl $d_{15}$	= 0.81 0.176
			"	Propyl $d_{15}$	= 0.816 0.033

## SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS ETHYL ALCOHOL SOLUTIONS.

(Bodländer — Z. physik. Ch. 7, 317, '91; Taylor — J. Phys. Ch. 1, 723, '97; also Bathrick — *ibid.* 1, 159, '96.)

### Results at 11.5° (B.).

Sp. Gr. of Solutions.	Gms. per 100 cc. Solution.		
	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	NaCl.
1.2035	0	86.62	31.73
1.1865	2.86	86.14	29.66
1.1710	5.41	83.93	27.77
1.1548	7.93	81.50	26.05
1.1350	10.84	78.78	24.28
1.1390	11.22	78.62	23.65
1.1088	16.85	73.40	20.63

### Results at 13° (B.).

Sp. Gr. of Solutions.	Gms. per 100 cc. Solution.		
	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	NaCl.
1.2030	0	88.70	31.60
1.1348	11.82	78.41	23.26
1.1144	15.99	74.64	20.81
1.0970	19.39	71.45	18.86
1.0698	24.95	65.80	16.23
1.0295	32.33	57.96	12.66
0.9880	40.33	49.34	9.13
0.9445	49.28	38.54	5.93
0.9075	57.91	29.37	3.41
0.8700	63.86	21.62	1.53
0.8400	72.26	11.24	0.50

### Results at 30° and at 40° (T.).

Wt. per cent Alcohol in Solvent.	At 30°. Gms. NaCl per 100 Gms.		At 40°. Gms. NaCl per 100 Gms.	
	Solution.	Water.	Solution.	Water.
0	26.50	36.05	26.68	36.38
5	24.59	34.29	24.79	34.69
10	22.66	32.57	22.90	33.00
20	19.05	29.40	19.46	30.20
30	15.67	26.53	16.02	27.25
40	12.45	23.70	12.75	24.37
50	9.34	20.60	9.67	21.42
60	6.36	16.96	6.65	17.82
70	3.36	12.75	3.87	13.10
80	1.56	7.95	1.69	8.68
90	0.43	4.30	0.50	5.10

100 gms. alcohol of 0.9282 Sp. Gr. = 45.0% by wt. dissolve at:

4°	10°	13°	23°	32°	33°	44°	51°	60°	
10.9	11.1	11.43	11.9	12.3	12.5	13.1	13.8	14.1	gms. NaCl

(Gerardin — Ann. chim. phys. [4] 5, 146.)

100 gms. of a mixture of equal parts of 96% alcohol and 98% et<sub>h</sub> dissolve 0.11 gm. NaCl.

(Mayer — Liebig's Ann. 98, 205, '5)



STABILITY OF SODIUM CHLORIDE IN AQUEOUS METHYL ALCOHOL.  
(Armstrong and Eyre, 1910-11.)

Results at 0°.		Results at 25°.	
Solvent, Gms. CH <sub>3</sub> OH per 100 Gms. H <sub>2</sub> O.	Gms. NaCl per 100 Gms. Sat. Sol.	Solvent, Gms. CH <sub>3</sub> OH per 1000 Gms. H <sub>2</sub> O.	Gms. NaCl per 100 Gms. Sat. Sol.
0	26.35	8.01	26.29
8.01	26.05	16.02	26.02
16.02	25.79	32.04	25.50
32.04	29.19	96.12	23.50

A solution of NaCl in CH<sub>3</sub>OH contains 0.1 gm. NaCl per 100 gms. solution at normal temperature.  
(Centnerswer, 1910.)

STABILITY OF SODIUM CHLORIDE IN AQUEOUS PROPYL ALCOHOL.  
(Armstrong and Eyre, 1910-11.)

1. propyl alcohol containing 15.01 gms. C<sub>3</sub>H<sub>7</sub>OH per 1000 cc. H<sub>2</sub>O dissolves 1 gm. NaCl per 100 gms. sat. solution at 0° and 25.95 gms. at 25°.  
2. propyl alcohol containing 30.02 gms. C<sub>3</sub>H<sub>7</sub>OH per 1000 cc. H<sub>2</sub>O dissolves 2 gms. NaCl per 100 gms. sat. solution at 0° and 25.37 gms. at 25°.

SOLUBILITY OF SODIUM CHLORIDE IN THE SYSTEM SODIUM CHLORIDE, NORMAL PROPYL ALCOHOL AND WATER AT 23-25°.  
(Frankforter and Frary, 1913.)

Authors have determined the binodal curve and quadruple points of the system and locate tie lines.

100 Gms. Homogeneous Liquid.		Gms. per 100 Gms. Homogeneous Liquid.		
C <sub>3</sub> H <sub>7</sub> OH.	H <sub>2</sub> O.	NaCl.	C <sub>3</sub> H <sub>7</sub> OH.	H <sub>2</sub> O.
87.7	11.75*	14.38	5.39	80.23
51.57	46.20	15.42	5.11	79.47
18.99	77.46	16.38	4.47	79.14
14.78	81.32	18.08	3.83	78.09
12.77	81.96	20.12	3.27	76.61
9.49	82.47	22.35	2.64	75.01
7.79	81.72	24.50	2.13	73.37
6.57	81.23	24.9	2.3	72.8*

\* Quad. pt.

Effect of temperature upon the equilibrium in the above system was greater than observed in any of the other systems investigated and additional data, illustrating the extent of the temperature influence, are given.

1. sat. sol. of NaCl in 99.6 per cent C<sub>3</sub>H<sub>7</sub>OH contains 0.04 gm. NaCl per 100 gms. solution.  
(Frankforter and Frary, 1913.)

SOLUBILITY OF SODIUM CHLORIDE IN THE SYSTEMS SODIUM CHLORIDE, ALLYL ALCOHOL, WATER, AT 20° AND SODIUM CARBONATE, ALLYL ALCOHOL, WATER, AT 20°.  
(Frankforter and Temple, 1915.)

Results for + CH <sub>2</sub> :CHCH <sub>2</sub> OH + H <sub>2</sub> O.			Results for Na <sub>2</sub> CO <sub>3</sub> + CH <sub>2</sub> :CH.CH <sub>2</sub> OH + H <sub>2</sub> O.		
per 100 Gms. Alcohol + Water.			Gms. per 100 Gms. Alcohol + Water.		
Alcohol.	Water.		Na <sub>2</sub> CO <sub>3</sub> .	Alcohol.	Water.
9	69.867	30.133	0.456	61.112	38.888
2	64.858	33.142	0.708	56.334	43.666
9	60.821	39.179	1.011	51.930	48.070
2	54.683	45.317	1.468	48.109	51.891
6	47.132	52.868	2.580	41.052	58.948
0	40.392	59.608	3.414	37.126	62.874
5	33.224	66.776	4.739	32.166	67.834
5	27.261	72.739	7.774	23.753	76.247
7	19.705	80.295	10.079	18.407	81.593



## SOLUBILITY OF SODIUM CHLORIDE IN SEVERAL ALCOHOLS AT 25°

(Turner and Bissett, 1913.)

Alcohol.	Gms. NaCl per 100 Gms. Alcohol.
Methyl Alcohol, $\text{CH}_3\text{OH}$	1.31
Ethyl Alcohol, $\text{C}_2\text{H}_5\text{OH}$	0.065
Propyl Alcohol, $\text{C}_3\text{H}_7\text{OH}$	0.012
Amyl Alcohol, $\text{C}_5\text{H}_{11}\text{OH}$	0.002

## SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS ACETONE SOLUTIONS AT 25°

(Frankforter and Cohen, 1914.)

Gms. per 100 Gms. Sat. Sol.			Gms. per 100 Gms. Sat. Sol.		
NaCl.	$\text{H}_2\text{O}$ .	$(\text{CH}_3)_2\text{CO}$ .	NaCl.	$\text{H}_2\text{O}$ .	$(\text{CH}_3)_2\text{CO}$ .
25.9	73.06	1.04	16.55	61.59	21.86
24.19	71.18	4.03	0.45	13.75	85.8*
20.85	66.78	12.37	0.32	13.92	85.76
18.32	63.16	18.52	0.19	10.82	88.99
17.89	62.21	19.90	0.12	8.94	90.94

\* Quad pt.

Between the concentration 21.86 and 85.8 per cent acetone, two layers formed. The binodal curve corresponding to this range of concentration determined and it is stated by the authors that tie lines were located by analytical data for them are not given. The results for the binodal curve follows:

Gms. per 100 Gms. Homogeneous Liquid.			Gms. per 100 Gms. Homogeneous Liquid.		
NaCl.	$\text{H}_2\text{O}$ .	$(\text{CH}_3)_2\text{CO}$ .	NaCl.	$\text{H}_2\text{O}$ .	$(\text{CH}_3)_2\text{CO}$ .
0.59	15.46	83.95	5.87	40.19	53.94
0.79	17.58	81.63	6.45	42.12	51.43
0.93	18.83	80.24	7.53	46.12	46.35
1.27	22.19	76.54	8.87	49.39	41.74
1.57	23.89	74.54	9.47	50.92	39.61
2.31	27.27	70.42	10.35	53.06	36.59
4.87	36.79	58.34	15.87	59.71	24.42

Additional data, showing the effect of temperature on the above system, are also given

## SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS SOLUTIONS OF:

Acetone at 20°.			Glycerol at 25°.		
(Herz and Knoch, 1904.)			(Herz and Knoch, 1905.)		
cc. Acetone per 100 cc. Solvent.	NaCl per 100 cc. Solution.		Wt. Per cent Glycerol in Solvent.	NaCl per 100 cc. Solution.	
	Millimols.	Gms.		Millimols.	Gms.
0	537.9	31.47	0	545.6	31.93
10	464.6	27.18	13.28	501.1	29.31
20	394.8	23.10	25.98	448.4	26.23
30	330.1	19.32	45.36	370.2	21.66
32 } Lower layer	308.5	18.05	54.23	333.9	19.54
87 } Upper layer	7.7	0.45	83.84	220.8	12.91
88	7.3	0.43	100 *	167.1	9.78
90	4.3	0.25			

\* Sp. Gr. of Glycerol, 1.2592. Impurities about 1.5%.

100 gms. sat. solution in glycol contain 31.7 gms. NaCl at 14.8°.

100 gms.  $\text{H}_2\text{O}$  dissolve 236.3 gms. sugar + 42.3 gms. NaCl at 31.2°  
 gms. sat. aq. solution contain 62.17 gms. sugar + 11.13 gms. NaCl. (de Cor)



## EQUILIBRIUM IN THE SYSTEM SODIUM CHLORIDE, METHYL ETHYL KETONE AND WATER AT 25° (BINODAL CURVE).

(Frankforter and Cohen, 1916.)

Gms. per 100 Gms. Homogeneous Liquid.			Gms. per 100 Gms. Homogeneous Liquid.		
NaCl	CH <sub>3</sub> CO.C <sub>2</sub> H <sub>5</sub>	H <sub>2</sub> O.	NaCl	CH <sub>3</sub> CO.C <sub>2</sub> H <sub>5</sub>	H <sub>2</sub> O.
3.5	20.13	79.52	6.75	10.80	82.45
5.5	19.75	79.70	10.07	7.65	82.28
4.2	16.52	82.06	14.32	5.36	80.32
8.0	17.70	80.50	14.65	3.83	81.52
1.47	16.24	81.29	23.15	2.08	74.77
1.11	13.34	82.55	24.14	0.94	74.92

## SOLUBILITY OF SODIUM CHLORIDE IN AQUEOUS SOLUTIONS OF CARBAMIDE (UREA) AND OF FORMAMIDE AT 25°.

(Ritzel, 1911.)

In Aqueous Carbamide.		In Aqueous Formamide.	
Gms. CO(NH <sub>2</sub> ) <sub>2</sub> per 100 cc. Solution.	Gms. NaCl per 100 cc. Solution.	Gms. HCO.NH <sub>2</sub> per 100 cc. Solution.	Gms. NaCl per 100 cc. Solution.
0	31.80	0	31.80
5	30.63	2.3	30.98
9.6	29.05	5.3	30.86
13	28.46	8	30.40
18	27.65	11	29.11
23	27.24	15	28.52
28	26.56	18.8	27.76

According to results by Fastert (1912), the solubility of sodium chloride in aqueous solutions of urea increases slightly with increase of urea in solution, thus:

100 gms. CO(NH <sub>2</sub> ) <sub>2</sub> per 100 cc. Sol.	10	20	30	40	50
100 gms. NaCl per 100 cc. Sol.	31.92	32.17	32.51	32.93	33.40

Data for equilibrium in the system sodium chloride, succinic acid nitrile, water given by Timmermans (1907).

50 gms. 95% formic acid dissolve 5.8 gms. NaCl at 19.7°. (Aschan, 1913.)

50 gms. hydroxylamine dissolve 14.7 gms. NaCl at 17.5°. (de Bruyn, 1892.)

50 cc. anhydrous hydrazine dissolve 8 gms. NaCl at room temp. (Welsh and Broderson, 1915.)

## FUSION-POINT DATA (Solubilities, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES.

NaCl + HCl.	(Derby, 1918.)
" + Na <sub>2</sub> CrO <sub>4</sub> .	(Sackur, 1911-12.)
" + NaCN.	(Truthe, 1912.)
" + NaF.	(Ruff and Plato, 1903; Wolters, 1910; Plato, 1907.)
" + NaOH.	(Scarpa, 1915.)
" + NaI.	(Ruff and Plato, 1903; Amadori, 1912a.)
" + NaNO <sub>2</sub> .	(Meneghini, 1912.)
" + Na <sub>4</sub> P <sub>2</sub> O <sub>7</sub> .	(LeChatelier, 1894.)
" + Na <sub>2</sub> SO <sub>4</sub> .	(Ruff and Plato, 1903; Knecke, 1908; Wolters, 1910; Sackur, 1911-12.)
" + SrCl <sub>2</sub> .	(Vortisch, 1914; Sackur, 1911-12.)
" + SrCO <sub>3</sub> .	(Sackur, 1911-12.)
" + TiCl <sub>4</sub> .	(Sandomini, 1911, 1914.)



# SODIUM CHROMATES

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## SODIUM CHROMATES (Mono, Di, etc.)

### SOLUBILITY IN WATER.

(Mylus and Funk, 1900; see also Salkowski, 1901.)

#### Sodium Monochromate.

t°.	Gms. Na <sub>2</sub> CrO <sub>4</sub> per 100 Gms. Solution.	Mols. Na <sub>2</sub> CrO <sub>4</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.
0	24.07	3.52	Na <sub>2</sub> CrO <sub>4</sub> ·10H <sub>2</sub> O
10	33.41	5.55	"
18*	40.10	7.43	"
18.5	41.65	7.94	"
19.5	44.78	9.01	"
21	47.40	10.00	"
25.6	46.08	9.52	Na <sub>2</sub> CrO <sub>4</sub> ·4H <sub>2</sub> O
31.5	47.05	9.90	"
36	47.98	10.2	"
40	48.97	10.6	"
45	50.20	11.6	"
49.5	50.93	11.5	"
54.5	52.28	12.2	"
59.5	53.39	12.7	"
65	55.23	13.7	Na <sub>2</sub> CrO <sub>4</sub>
70	55.15	13.6	"
80	55.53	13.8	"
100	55.74	14.0	"

#### Sodium Dichromate.

t°.	Gms. Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> per 100 Gms. Solution.	Mols. Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.
0	61.98	11.2	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> ·2H <sub>2</sub> O
17	63.82	12.1	"
18†	63.92	12.16	"
34.5	67.36	14.2	"
52	71.76	17.4	"
72	76.9	22.8	"
81	79.8	27.1	"
93	81.19	29.6	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>
98	81.25	29.8	"

#### Sodium Tri Chromate.

t°.	Gms. Na <sub>2</sub> Cr <sub>3</sub> O <sub>10</sub> per 100 Gms. Solution.	Mols. Na <sub>2</sub> Cr <sub>3</sub> O <sub>10</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.
0	80.03	19.9	Na <sub>2</sub> Cr <sub>3</sub> O <sub>10</sub> ·H <sub>2</sub> O
15†	80.44	20.4	"
18	80.60	20.56	"
55	82.68	23.7	"
99	85.78	29.9	"

\* Sp. Gr. of sat. sol. at 18° = 1.432.

† Sp. Gr. of sat. sol. at 18° = 2.059

‡ Sp. Gr. of sat. solution at 18° = 1.745.

#### Sodium Tetrachromate.

t°.	Gms. Na <sub>2</sub> Cr <sub>4</sub> O <sub>13</sub> per 100 Gms. Solution.	Mols. Na <sub>2</sub> Cr <sub>4</sub> O <sub>13</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.
0	72.96	10.5	Na <sub>2</sub> Cr <sub>4</sub> O <sub>13</sub> ·4H <sub>2</sub> O
16	74.19	11.2	"
18*	74.60	11.27	"
22	76.01	12.3	"

#### Tetrasodium Chromate.

t°.	Gms. Na <sub>4</sub> CrO <sub>6</sub> per 100 Gms. Solution.	Mols. Na <sub>4</sub> CrO <sub>6</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.
0	33.87	4.11	Na <sub>4</sub> CrO <sub>6</sub> ·2H <sub>2</sub> O
10	35.58	4.42	"
18†	37.50	4.81	"
27.7	40.09	5.38	"
37	45.13	6.62	"

\* Sp. Gr. of sat. solution at 18° = 1.926.

† Sp. Gr. of sat. solution at 18° = 1.446.

A new hydrate of sodium chromate, Na<sub>2</sub>CrO<sub>4</sub>·6H<sub>2</sub>O, was found by Salkowski (1901) and the following data for its range of existence were determined.

t°.	Gms. Na <sub>2</sub> CrO <sub>4</sub> per 100 Gms. Solution.	Mols. Na <sub>2</sub> CrO <sub>4</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.	t°.	Gms. Na <sub>2</sub> CrO <sub>4</sub> per 100 Gms. Sol.	Mols. Na <sub>2</sub> CrO <sub>4</sub> per 100 Mols. H <sub>2</sub> O.	Solid Phase.
17.7	43.65	8.62	Na <sub>2</sub> CrO <sub>4</sub> ·10H <sub>2</sub> O	25.9	46.3*	9.57	Na <sub>2</sub> CrO <sub>4</sub> ·6H <sub>2</sub> O
19.2	44.12	8.77	"				+ Na <sub>2</sub> CrO <sub>4</sub> ·4H <sub>2</sub> O
19.525	44.2*	...	" + Na <sub>2</sub> CrO <sub>4</sub> ·6H <sub>2</sub> O	28.9	46.47	9.64	Na <sub>2</sub> CrO <sub>4</sub> ·4H <sub>2</sub> O
21.2	44.64	8.96	Na <sub>2</sub> CrO <sub>4</sub> ·6H <sub>2</sub> O	29.7	46.54	9.67	"
24.7	45.75	9.37	"	31.2	47.08	9.88	"

\* This determination by Richards and Kelley (1911).



## SOLUBILITY OF SODIUM CHROMATES IN WATER AT 30°.

(Schreinmakers, 1906.)

Composition in weight per cent:

Of Solution.		Of Residue.		Solid Phase.
% CrO <sub>3</sub> .	% Na <sub>2</sub> O.	% CrO <sub>3</sub> .	% Na <sub>2</sub> O.	
0	± 42	...	...	NaOH.H <sub>2</sub> O
2.00	41.44	5.83	42.64	NaOH.H <sub>2</sub> O + Na <sub>2</sub> CrO <sub>4</sub>
2.04	40.89	...	...	Na <sub>2</sub> CrO <sub>4</sub>
4.23	35.51	27.52	36.57	"
6.64	32.34	27.72	34.60	"
15.19	27.06	37.07	32.20	"
10.22	29.39	15.48	28.41	Na <sub>2</sub> CrO <sub>4</sub> + Na <sub>2</sub> CrO <sub>7</sub> .12H <sub>2</sub> O
8.93	28.49	18.09	26.89	Na <sub>2</sub> CrO <sub>7</sub> .12H <sub>2</sub> O
8.62	26.91	...	...	"
13.12	23.91	18.57	25.92	"
18.44	22.86	...	...	"
19.26	22.98	21.54	25.31	Na <sub>2</sub> CrO <sub>7</sub> .12H <sub>2</sub> O + Na <sub>2</sub> CrO <sub>4</sub> .4H <sub>2</sub> O
17.84	24.21	26.24	24.98	Na <sub>2</sub> CrO <sub>4</sub> .4H <sub>2</sub> O
28.82	17.88	31.97	23.47	"
38.93	16.30	40.70	20.83	"
48.70	16.49	47.49	19.75	Na <sub>2</sub> CrO <sub>4</sub> .4H <sub>2</sub> O + Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> .2H <sub>2</sub> O
50.68	15.72	...	...	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> .2H <sub>2</sub> O
58.08	13.89	62.76	17.38	"
66.13	13.70	69.48	16.06	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> .2H <sub>2</sub> O + Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> .10H <sub>2</sub> O
65.98	14.15	69.46	15.15	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> .10H <sub>2</sub> O
68.46	10.95	73.88	13.38	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> .10H <sub>2</sub> O + Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> .4H <sub>2</sub> O
66.88	9.85	71.27	10.67	Na <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> .4H <sub>2</sub> O
70.06	11.85	83.95	9.57	" (?)
69.04	11.04	81.80	6.43	CrO <sub>3</sub>
67.84	9.81	82.85	5.42	"
64.48	4.51	79.49	2.71	"
62.28	0.0	...	...	"

100 gms. of a saturated aqueous solution contain at 30°:

627 gms. Na<sub>2</sub>CrO<sub>4</sub>, or 100 gms. H<sub>2</sub>O dissolve 87.36 gms. Na<sub>2</sub>CrO<sub>4</sub>.4 gms. Na<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>, or 100 gms. H<sub>2</sub>O dissolve 197.6 gms. Na<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>.100 gms. absolute methyl alcohol dissolve 0.345 gms. Na<sub>2</sub>CrO<sub>4</sub> at 25°.

(de Bruyn, 1892.)

data for equilibrium in the system sodium chromate, sodium sulfate and water<sup>1</sup> and at 25° are given by Takenchi (1915). The mixtures were rotated at constant temperature until attainment of equilibrium and both the saturated solutions and the undissolved residues were analyzed. Very extensive tables of results are given. The decahydrates of sodium and chromium are isomorphous and the results show that these two salts are mutually miscible in all proportions. At 25° the solubility curve consists of three branches. The solutions of the first branch are in equilibrium with decahydrated mixed crystals, those of the second branch with anhydrous sulfate and those of the third with both anhydrous sodium sulfate and hexahydrated sodium chromate.



**SODIUM CHROMATES**

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**SOLUBILITY OF SODIUM DICHROMATE IN ALCOHOL AT 19.4°.**  
(Reinitzer, 1913.)

An excess of  $\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$  was shaken with absolute alcohol for 10 minutes and the mixture filtered. The filtrate contained 5.132 gms.  $\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$  per 100 cc. and its  $d_{19.4}$  was 0.8374. The solution decomposed within a few minutes with production of a brown precipitate and evolution of an aldehyde odor. The results are, therefore, only approximately correct.

**SODIUM CINNAMATE**  $\text{C}_6\text{H}_5\text{CH}:\text{CHCOONa}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 9.1 gms. sodium cinnamate at 15.20°.

100 cc. 90% alcohol dissolve 0.625 gm. at 15-20°. (Squire and Cairns, 1905.)

**SODIUM CITRATE**  $(\text{CH}_3)_3\text{COH}(\text{COONa})_3 \cdot 5\frac{1}{2}\text{H}_2\text{O}$ .**SOLUBILITY IN AQUEOUS ETHYL ALCOHOL AT 25°.**  
(Seidell, 1910.)

Wt. Per cent $\text{C}_2\text{H}_5\text{OH}$ in Solvent.	$d_{25}$ of Sat. Sol.	Gms. $\text{C}_6\text{H}_5\text{O}_7\text{Na}_3 \cdot$ $5\frac{1}{2}\text{H}_2\text{O}$ per 100 Gms. Sat. Sol.	Wt. Per cent $\text{C}_2\text{H}_5\text{OH}$ in Solvent.	$d_{25}$ of Sat. Sol.	Gms. $\text{C}_6\text{H}_5\text{O}_7\text{Na}_3 \cdot$ $5\frac{1}{2}\text{H}_2\text{O}$ per 100 Gms. Sat. Sol.
0	1.276	48.1	40	0.953	4.5
10	1.190	37.4	50	0.918	1.4
20	1.100	25	60	0.892	0.3
30	1.006	11.8	100	0.789	0

Data for equilibrium in the system sodium hydroxide, citric acid, phosphoric acid and water at 20° are given by Pratolongo (1913).

The author fails to describe clearly the terms in which the results are expressed, consequently their exact meaning is not clear.

**SODIUM (Ferro) CYANIDE**  $\text{Na}_4\text{Fe}(\text{CN})_6$ .**SOLUBILITY IN WATER.**  
(Conroy, 1898.)

t°.	20°.	42°.	80°.	98.5°.
Gms. $\text{Na}_4\text{Fe}(\text{CN})_6$ per 100 gms. $\text{H}_2\text{O}$	17.9	30.2	59.2	63

**SODIUM FLUORIDE**  $\text{NaF}$ .

100 gms. sat. aq. solution contain 4.3 gms.  $\text{NaF}$  at 18°. Sp. Gr. of solution = 1.044. (Mylius and Funk, 1891.)

**SOLUBILITY OF SODIUM FLUORIDE IN AQUEOUS SOLUTIONS OF HYDROFLUORIC ACID AT 21°.**  
(Ditte, 1896.)

Gms. per 1000 Gms. $\text{H}_2\text{O}$ .			Gms. per 1000 Gms. $\text{H}_2\text{O}$ .		
0	HF	41.7 NaF	83.8	HF	22.9 NaF
10	"	41.4 "	129.7	"	23.8 "
45.8	"	22.5 "	596.4	"	48.8 "
56.5	"	22.7 "	777.4	"	81.7 "

**FUSION-POINT DATA** (Solubility, see footnote, p. 1) ARE GIVEN FOR THE FOLLOWING MIXTURES.

$\text{NaF} + \text{FeF}_3$ .	(Puschin and Baskov, 1913.)
" + $\text{ZnF}_2$ .	" "
" + $\text{NaI}$ .	(Ruff and Plato, 1903.)
" + $\text{NaOH}$ .	(Scarpa, 1915.)
" + $\text{Na}_2\text{SO}_4$ .	(Wolters, 1910.)

**SODIUM FLUOSILICATE**  $\text{Na}_2\text{SiF}_6$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 0.65 gm. at 17.5°, and 2.45 gms. at 100°. (Stolba, 18;



**III FORMATE HCOONa.****SOLUBILITY IN WATER.**

(Groschuff, 1903.)

Gms. HCOONa per 100 Gms. Solution.	Mols. HCOONa per 100 Mols. H <sub>2</sub> O.	Solid Phase.	t°.	Gms. HCOONa per 100 Gms. Solution.	Mols. HCOONa per 100 Mols. H <sub>2</sub> O.	Solid Phase.
22.80	7.82	HCOONa·3H <sub>2</sub> O	25.5	50.53	27.0	HCOONa·3H <sub>2</sub> O
30.47	11.6	"	18	49.22	25.65	HCOONa
41.88	19.1	"	29	50.44	26.9	"
44.92	21.6	"	54	53.80	30.8	"
44.73	21.4	HCOONa·3H <sub>2</sub> O	74.5	56.82	34.8	"
46.86	23.3	"	100.5	61.54	42.35	"
48.22	24.65	"	123	66.20	51.8	"

Gr. of the saturated solution of the dihydrate at 18° = 1.317.

**SOLUBILITY OF SODIUM ACID FORMATE (EXPRESSED AS NEUTRAL SALT) IN AQUEOUS SOLUTIONS OF FORMIC ACID.**

(Groschuff.)

Gms. HCOONa per 100 Gms. Solution.	Mols. HCOONa per 100 Mols. H <sub>2</sub> O.	Solid Phase.	t°.	Gms. HCOONa per 100 Gms. Solution.	Mols. HCOONa per 100 Mols. H <sub>2</sub> O.	Solid Phase.
22.35	19.5	HCOONa·HCOOH	45.5	38.85	43.1	HCOONa
29.62	28.45	"	70	41.27	47.5	"
41.08	47.1	"	85	43.09	51.2	"

**III GLYCEROPHOSPHATE (Disodium) OP(OC<sub>2</sub>H<sub>5</sub>O<sub>2</sub>)(ONa)<sub>2</sub>·5H<sub>2</sub>O.**gms. sat. solution in H<sub>2</sub>O contain 27.38 gms. of the anhydrous salt at 18°.

(Rogier and Fiore, 1913.)

**III HYDROXIDE NaOH.****SOLUBILITY IN WATER.**

(Pickering, 1893; Mylius and Funk (Dietz), 1900.)

Gms. NaOH per 100 Gms. Solution.	Gms. Water.	Solid Phase.	t°.	Gms. NaOH per 100 Gms. Solution.	Gms. Water.	Solid Phase.
8.0	8.7	Ice	20	52.2	109	NaOH·H <sub>2</sub> O
16.0	19.1	"	30	54.3	119	"
19.0	23.5	Ice + NaOH·7H <sub>2</sub> O	40	56.3	129	"
22.2	28.5	NaOH·7H <sub>2</sub> O + NaOH·5H <sub>2</sub> O	50	59.2	145	"
24.5	32.5	NaOH·5H <sub>2</sub> O + NaOH·4H <sub>2</sub> O	60	63.5	174	"
29.6	42.0	NaOH·4H <sub>2</sub> O	64.3	69.0	222.3	" f. pt.
32.2	47.5	NaOH·4H <sub>2</sub> O + NaOH·3½H <sub>2</sub> O	61.8	74.2	288	NaOH·H <sub>2</sub> O + NaOH
34.0	51.5	NaOH·3½H <sub>2</sub> O	80	75.8	313	NaOH (?)
38.9	63.53	" f. pt.	110	78.5	365	"
45.5	83.5	NaOH·3½H <sub>2</sub> O + NaOH·3H <sub>2</sub> O	192	83.9	521	"
50.7	103.0	NaOH·3H <sub>2</sub> O + NaOH·H <sub>2</sub> O				

Gr. of sat. solution at 18° = 1.539.

Determinations of the Sp. Gr. of sodium hydroxide solution, see Kohlrausch, Vegscheider and Walter, 1905.

gms. of the sat. solution in water contain 46.36 gms. NaOH at 15°.

(de Forcrand, 1909a.)



## SODIUM HYDROXIDE

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1000 gms. liquid ammonia dissolve 0.0025 gm. NaOH at  $-40^{\circ}$ .

(Skonsarsky and Tchitchinadze, 1916.)

Data for equilibrium in the system sodium hydroxide, resorcinol and water at  $30^{\circ}$  are given by van Meurs (1916).

Fusion-point data for NaOH + NaI are given by Scarpa (1915).

## SODIUM IODATE $\text{NaIO}_3$ .

SOLUBILITY IN WATER. (Gay-Lussac; Kremers, 1856a.)

$t^{\circ}$ .	$0^{\circ}$ .	$20^{\circ}$ .	$40^{\circ}$ .	$60^{\circ}$ .	$80^{\circ}$ .	$100^{\circ}$ .
Gms. $\text{NaIO}_3$ per 100 gms. $\text{H}_2\text{O}$	2.5	9	15	21	27	34

EQUILIBRIUM IN THE SYSTEM SODIUM IODATE, IODIC ACID AND WATER AT  $30^{\circ}$ .  
(Meerburg, 1905.)

Gms. per 100	Gms. Sat. Sol.	Solid Phase.	Gms. per 100	Gms. Sat. Sol.	Solid Phase.
$\text{HIO}_3$ .	$\text{NaIO}_3$ .		$\text{HIO}_3$ .	$\text{NaIO}_3$ .	
0	9.36	$\text{NaIO}_3 \cdot 1\frac{1}{2}\text{H}_2\text{O}$	11.20	7.54	$\text{Na}_2\text{O} \cdot 2\text{I}_2\text{O}_5$
1.98	9.52	"	11.82	7.20	" + $\text{NaIO}_3 \cdot 1\frac{1}{2}\text{H}_2\text{O}$
4.86	10.22	"	11.62	5.65	$\text{NaIO}_3 \cdot \text{HIO}_3$
5.86	11.04	"	23.23	3.69	"
7.40	11.60	" unstable	32.68	2.91	"
9.73	14.73	" "	46.62	2.67	"
6.70	11.21	" + $\text{Na}_2\text{O} \cdot 2\text{I}_2\text{O}_5$	55.48	2.12	"
7.80	10.30	$\text{Na}_2\text{O} \cdot 2\text{I}_2\text{O}_5$	65.47	1.83	"
9.15	9	"	76.19	1.42	" + $\text{HIO}_3$
9.93	8.71	"	76.70	0	$\text{HIO}_3$

## SODIUM IODIDE $\text{NaI} \cdot 2\text{H}_2\text{O}$ .

SOLUBILITY IN WATER.

(de Coppet, 1883; see also Etard, 1884; and Kremers, 1856a.)

$t^{\circ}$ .	Grams NaI per 100 Gms.	Solid Phase.	$t^{\circ}$ .	Grams NaI per 100 Gms.	Solid Phase.
	Water.	Solution.		Water.	Solution.
20	148.0	59.7	60	256.8	72.0
0	158.7	61.4	65	278.4	73.6
10	168.6	62.8	67	293	74.6
20	178.7	64.1	70	294	74.6
25	184.2	64.8	80	296	74.7
30	190.3	65.6	100	302	75.1
40	205.0	67.2	120	310	75.6
50	227.8	69.5	140	321	76.3

The eutectic mixture of Ice +  $\text{NaI} \cdot 5\text{H}_2\text{O}$  is at  $-31.5^{\circ}$  and contains about 39 per cent NaI.

(Meyerhoffer, 1904.)

The tr. pt. for  $\text{NaI} \cdot 5\text{H}_2\text{O}$  +  $\text{NaI} \cdot 2\text{H}_2\text{O}$  is at  $-13.5$  and the saturated solution contains 60.2 gms. NaI per 100 gms.

(Panfiloff, 1893a.)

The tr. pt. for  $\text{NaI} \cdot 2\text{H}_2\text{O}$  + NaI is at  $64.3^{\circ}$  and the saturated solution contains 74.4 gms. NaI per 100 gms.

(Panfiloff, 1893.)

100 gms.  $\text{H}_2\text{O}$  dissolve 172.4 gms. NaI at  $15^{\circ}$  and the  $d_{15}$  of the sol. is 1.8937.

(Greenish, 1900.)

100 gms. sat. solution in  $\text{H}_2\text{O}$  contain 65.5 gms. NaI at  $30^{\circ}$ .

(Cocheret, 1911.)

## SOLUBILITY OF SODIUM IODIDE IN ALCOHOLS AT $25^{\circ}$ .

(Turner and Bissett, 1913.)

100 gms.	Methyl alcohol,	$\text{CH}_3\text{OH}$	dissolve	90.35 gms.	NaI.
"	Ethyl	$\text{C}_2\text{H}_5\text{OH}$	"	46.02	"
"	Propyl	$\text{C}_3\text{H}_7\text{OH}$	"	28.22	"
"	Amyl	$\text{C}_5\text{H}_{11}\text{OH}$	"	16.30	"



## SOLUBILITY OF SODIUM IODIDE IN AQUEOUS ETHYL ALCOHOL AT 30°.

(Cocheret, 1911.)

Gms. per 100 Gms. Sat. Sol.	C <sub>2</sub> H <sub>5</sub> OH.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
			NaI.	C <sub>2</sub> H <sub>5</sub> OH.	
2	0	NaI.2H <sub>2</sub> O	38.5	53.2	NaI.2H <sub>2</sub> O
	3.42	"	37.49	55.37	" + NaI
	18.5	"	35.65	59.24	NaI
	28.5	"	33.24	61.78	"
5	41.7	"	30.90	68.70	"

are also given for the solubility of mixtures of NaI + Na<sub>2</sub>CO<sub>3</sub> in aqueous alcohol at 30°.

## SOLUBILITY OF SODIUM IODIDE IN ABSOLUTE ETHYL ALCOHOL AT TEMPERATURES UP TO THE CRITICAL POINT.

(Tyrer, 1910a.)

Gms. NaI per 100 Gms. C <sub>2</sub> H <sub>5</sub> OH	t°.	Gms. NaI per 100 Gms. C <sub>2</sub> H <sub>5</sub> OH.	t°.	Gms. NaI per 100 Gms. C <sub>2</sub> H <sub>5</sub> OH.
43.77	120	45.2	240	32.7
44.25	160	45	250	26.2
44.50	180	44.3	255	21
45	200	42.3	260	10.8
45.1	220	38.5	261.5*	8.6
	230	36.2		

\* crit. t. of solution.

mixtures were placed in sealed glass tubes which were heated in a specially heated, electrically heated air bath. The temperature at which the last of salt just dissolved was determined in each case. The experiments were with very great care. Results are also given for the solubility of sodium iodide in the vapor of ethyl alcohol above the critical point.

## SOLUBILITY OF SODIUM IODIDE IN MIXTURES OF ALCOHOLS AT 25°.

(Herr and Kuhn, 1908.)

H <sub>2</sub> O + C <sub>2</sub> H <sub>5</sub> OH.			In CH <sub>3</sub> OH + C <sub>2</sub> H <sub>5</sub> OH.			In C <sub>2</sub> H <sub>5</sub> OH + C <sub>2</sub> H <sub>5</sub> OH.		
d <sub>4</sub> <sup>25</sup> of Sat. Sol.	Gms. NaI per 100 cc. C <sub>2</sub> H <sub>5</sub> OH in Sat. Sol.	Per cent C <sub>2</sub> H <sub>5</sub> OH in Mixture.	d <sub>4</sub> <sup>25</sup> of Sat. Sol.	Gms. NaI per 100 cc. C <sub>2</sub> H <sub>5</sub> OH in Sat. Sol.	Per cent C <sub>2</sub> H <sub>5</sub> OH in Mixture.	d <sub>4</sub> <sup>25</sup> of Sat. Sol.	Gms. NaI per 100 cc. C <sub>2</sub> H <sub>5</sub> OH in Sat. Sol.	Per cent C <sub>2</sub> H <sub>5</sub> OH in Mixture.
1.0806	35.15	0	1.3250	63.22	0	1.0806	35.15	0
1.1029	37.68	11.11	1.2853	58.45	8.1	1.0732	34.60	0
1.1123	38.71	23.8	1.2528	54.64	17.85	1.0720	34.05	0
1.1742	45.98	65.2	1.1387	40.71	56.6	1.0276	28.41	0
1.2741	57.44	91.8	1.0420	29.14	88.6	1.0130	26.13	0
1.2886	58.92	93.75	1.0178	26.49	91.2	1.0104	25.88	0
1.3056	61.10	100	0.9968	24.11	95.2	1.0020	24.74	0
1.3250	63.22				100	0.9968	24.11	0

## SOLUBILITY OF SODIUM IODIDE IN SEVERAL SOLVENTS.

(At 22.5°, de Bruyn, 1892; at ord. temp. Rohland, 1898; Walden, 1906.)

Solvent.	t°.	Gms. NaI per 100 Gms. Solvent.	Solvent.	Gms. NaI per 100 cc. Sat. Solution.	
				at 0°.	at 25°.
ethyl Alcohol	22.5	43.1	Acetonitrile	22.09	18.43
Alcohol, d <sub>15</sub> = 0.810	ord. temp.	58.8	Propionitrile	9.09	6.23
Methyl Alcohol	22.5	77.7	Nitro Methane	0.34	0.48
Alcohol, d <sub>15</sub> = 0.799	ord. temp.	83.3	Acetone	very soluble	
Alcohol, d <sub>15</sub> = 0.816	ord. temp.	26.3	Furfural	...	25.10



**SOLUBILITY OF SODIUM IODIDE IN ACETAMIDE.**  
(Menschutkin, 1908.)

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase	t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase
	$\text{NaI} \cdot \frac{1}{2} \text{CH}_3\text{CONH}_2 = \text{NaI}$				$\text{NaI} \cdot \frac{1}{2} \text{CH}_3\text{CONH}_2 = \text{NaI}$		
82	m. pt. of pure acetamide		$\text{CH}_3\text{CONH}_2$	50	59	33	$\text{NaI} \cdot \frac{1}{2} \text{CH}_3\text{COI}$
78	9.5	5.32	"	60	60.5	33.9	"
74	18	10.08	"	70	62.2	34.8	"
70	25.5	14	"	80	64.2	35.9	"
66	31.9	17.86	"	90	66.5	37.2	"
62	37.3	20.9	"	100	69.2	38.7	"
58	41.9	23.44	"	110	72.6	40.6	"
54	46.1	25.8	"	120	78.7	44	"
50	50	28	"	125	84.7	47.4	" + NaI
46	53.7	30.1	"	150	85.1	47.7	NaI
41.5	57.7	32.3	" + $\text{NaI} \cdot \frac{1}{2} \text{CH}_3\text{CONH}_2$	175	85.5	47.9	"

100 cc. anhydrous hydrazine dissolve 64 gms. NaI at room temp.

(Welsh and Broderson)

**SODIUM IODOMERCURATE**

A saturated solution at 24.75°, prepared by adding NaI and  $\text{HgI}_2$  in exc. water, contained 4.59% Na, 25% Hg, 58.25% I and 12.2%  $\text{H}_2\text{O}$ , correspond to 0.20 mol. alkali, 0.12 mol. Hg and 0.45 mol. I.

(Duboin)

**SODIUM MOLYBDATE**  $\text{Na}_2\text{MoO}_4$ .

**SOLUBILITY IN WATER.**

(Funk, 1900a.)

t°.	Gms. $\text{Na}_2\text{MoO}_4$ per 100 Gms. Solution.		Mols. $\text{Na}_2\text{MoO}_4$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Na}_2\text{MoO}_4$ per 100 Gms. Solution.		Mols. $\text{Na}_2\text{MoO}_4$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase
0	30.63	3.86		$\text{Na}_2\text{MoO}_4 \cdot 10\text{H}_2\text{O}$	15.5	39.27	5.65		$\text{Na}_2\text{MoO}_4$
4	33.83	4.47		"	18	39.40	5.70		"
6	35.58	4.83		"	32	39.82	5.78		"
9	38.16	5.39		"	51.5	41.27	6.14		"
10	39.28	5.65		$\text{Na}_2\text{MoO}_4 \cdot 2\text{H}_2\text{O}$	100	45.57	7.32		"

$d$  of the sat. sol. at 18° is 1.437.

100 gms.  $\text{H}_2\text{O}$  dissolve 3.878 gms. sodium trimolybdate,  $\text{Na}_2\text{Mo}_2\text{O}_{10}$ , at 20  
13.7 gms. at 100°.

(Ullik)

100 cc.  $\text{H}_2\text{O}$  dissolve 28.39 gms.  $\text{Na}_2\text{O} \cdot 4\text{MoO}_3 \cdot 6\text{H}_2\text{O}$  at 21°,  $d_{25} = 1.47$ . (Wemp)  
Fusion-point data for  $\text{Na}_2\text{MoO}_4 + \text{Na}_2\text{WO}_4$  and  $\text{Na}_2\text{MoO}_4 + \text{Na}_2\text{SO}_4$  are  
by Boeke (1907).

**SODIUM NITRATE**  $\text{NaNO}_3$ .

**SOLUBILITY IN WATER.**

(Mulder; Berkeley, 1904; see also Ditte, 1875; Maumee, 1864; Etard, 1894.)

t°.	Gms. NaNO <sub>3</sub> per 100 Gms.		Mols. per Liter.	t°.	Gms. NaNO <sub>3</sub> per 100 Gms.		Mols. per Liter.
	Solution.	Water.			Solution.	Water.	
0	42.2	72.9-73	* 6.71*	80	59.7	148-148.	* 1
10	44.7	80.8-80.5	7.16	100	64.3	180-175.8	1
20	46.7	87.5-88	7.60	120	68.6	218-208.8†	1
25	47.6	91-92	7.80	180	78.1	356.7	
30	48.7	94.0-96.2	8.06	220	83.5	506	
40	50.5	102-104.9	8.51	225	91.5	1076	
50	52.8	112-114	8.97	313‡	100	∞	
60	54.9	122-124	9.42	...			

\* Berkeley.

‡ at 119°.

§ m.pt.



**SOLUBILITY OF SODIUM NITRATE IN AQUEOUS AMMONIA SOLUTIONS AT 15°.**  
(Fedotieff and Koltunoff, 1914.)

In Aqueous $\text{NH}_3$ .			In Aqueous $\text{NH}_3 + \text{NH}_4\text{NO}_3$ .			
No. of Sol.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .		$d_{15}$ of Sat. Sol.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .		
	$\text{NH}_3$ .	$\text{NaNO}_3$ .		$\text{NH}_3$ .	$\text{NH}_4\text{NO}_3$ .	$\text{NaNO}_3$ .
253	13.87	75.03	1.324	12.91	83.51	74.10
233	17.28	73.99	1.330	16.97	128.9	69.40
212	20.38	73.18				

**SOLUBILITY OF SODIUM NITRATE IN AQUEOUS SOLUTIONS OF NITRIC ACID AT 0°.**  
(Engel, 1887; see also Schultz, 1860.)

Equivalents per 10 cc. Solution.		Sp. Gr. of Solutions.	Grams per 100 cc. Solution.	
$\text{NaNO}_3$	$\text{HNO}_3$		$\text{NaNO}_3$	$\text{HNO}_3$
66.4	0	1.341	56.5	0.00
63.7	2.65	1.338	54.2	1.67
60.5	5.7	1.331	51.48	3.59
56.9	8.8	1.324	48.42	5.55
52.75	12.57	1.312	44.88	7.92
48.7	16.9	1.308	41.44	10.65
39.5	27.0	1.291	33.61	17.02
35.1	32.25	1.285	29.86	20.33
31.1	37.25	1.282	26.46	23.48
23.5	48.0	1.276	20.0	30.26
18.0	57.25	1.276	15.32	36.09
12.9	71.0	1.261	10.97	44.76

**SOLUBILITY OF MIXTURES OF SODIUM NITRATE AND POTASSIUM NITRATE IN WATER AT 20°.**  
(Carnelly and Thomson, 1888.)

Per cent $\text{NaNO}_3$ in Mixtures Used.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .		Per cent $\text{NaNO}_3$ in Mixtures Used.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .	
	$\text{NaNO}_3$	$\text{KNO}_3$		$\text{NaNO}_3$	$\text{KNO}_3$
100	86.8	0	45.7	53.3	34.7
90	96.4	13.2	40	45.6	35.5
80	98.0	38.5	20	20.8	33.3
60	90.0	47.6	10	9.4	31.5
50	66.0	40.0	0	0.0	33.6

10 gms.  $\text{H}_2\text{O}$  dissolve 24.9 gms.  $\text{NaCl} + 53.6$  gms.  $\text{NaNO}_3$  at 20°.  
(Rüdorff, 1873; Karsten; Nicol, 1891.)

**SOLUBILITY OF SODIUM NITRATE IN AQUEOUS SOLUTIONS OF SODIUM HYDROXIDE AT 0°.**  
(Engel, 1891.)

Milligram Mols. per 10 cc. Solution.		Sp. Gr. of Solutions.	Grams per 100 cc. Solution.	
$\text{Na}_2\text{O}$	$\text{NaNO}_3$		$\text{NaOH}$	$\text{NaNO}_3$
0.0	66.4	1.341	0.0	56.50
2.875	62.5	1.338	2.30	53.19
6.1	57.15	1.333	4.89	48.63
12.75	47.5	1.327	10.21	40.42
26.0	29.5	1.326	20.83	25.10
39.0	17.5	1.332	31.25	14.89
45.88	13.19	1.356	36.76	11.22
60.88	6.05	1.401	48.75	5.15



Data for equilibrium in the system sodium nitrate, sodium sulfate and <sup>water at</sup> 10°, 20°, 25°, 30°, 34° and 35° are given by Massink (1916, 1917).

SOLUBILITY OF SODIUM NITRATE IN AQUEOUS SOLUTIONS OF SODIUM THIOSULFATE.

(Kremann and Rodemund, 1914.)

Results at 9°.			Results at 25°.		
Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
NaNO <sub>3</sub> .	Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> .		NaNO <sub>3</sub> .	Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> .	
33.31	12.26	NaNO <sub>3</sub>	35.42	12.72	NaNO <sub>3</sub>
22.57	23.41	" + Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> ·5H <sub>2</sub> O	25.40	24.25	"
4.22	34.77	Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> ·5H <sub>2</sub> O	19.90	31.81	" + Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>
			18.02	32.83	Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>
			4.33	40.50	"

SOLUBILITY OF SODIUM NITRATE IN ALCOHOLS.

100 gms. abs. methyl alcohol dissolve 0.41 gm. NaNO<sub>3</sub> at 25°.

100 gms. abs. ethyl alcohol dissolve 0.036 gm. NaNO<sub>3</sub> at 25°. (de Bruyn)

SOLUBILITY OF SODIUM NITRATE IN AQUEOUS ETHYL ALCOHOL AT DIFFERENT TEMPERATURES.

(Bodländer, 1891; Taylor, 1897; Bathrick, 1896.)

Results at 13° (B.).				Results at 16.5° (B.).			
Sp. Gr. of Solutions.	Gms. per 100 cc. Solution.			Sp. Gr. of Solutions.	Gms. per 100 cc. Solution.		
	C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	NaNO <sub>3</sub> .		C <sub>2</sub> H <sub>5</sub> OH.	H <sub>2</sub> O.	NaNO <sub>3</sub> .
1.3700	0.0	75.34	61.66	1.3745	0.0	75.25	62.20
1.3395	3.08	73.53	57.34	1.3162	6.16	70.82	54.64
1.3120	6.01	71.81	53.39	1.2576	11.60	68.10	46.00
1.2845	8.30	70.85	49.30	1.2140	16.49	65.04	39.87
1.2580	10.91	69.47	45.42	1.1615	22.17	61.67	32.31
1.2325	13.77	67.12	42.36	1.0855	32.22	52.92	23.41
1.2010	16.46	66.16	37.48	1.0558	37.23	48.50	19.85
				1.0050	43.98	42.78	13.74
				0.9420	52.60	32.13	9.47
				0.9030	60.00	25.65	4.65
				0.8610	63.16	21.31	1.63

Results at 30° (T.).			Results at 40° (Bathrick).	
Wt. per cent Alcohol in Solvent.	Gms. NaNO <sub>3</sub> per 100 Gms.		Wt. per cent Alcohol.	Gms. NaNO <sub>3</sub> per 100 Gms. Aq. Alcohol.
	Solution.	Water.		
0	49.10	96.45	0	104.5
5	46.41	91.15	8.22	90.8
10	43.50	85.55	17.4	73.3
20	37.42	74.75	26.0	61.6
30	31.31	65.10	36.0	48.4
40	25.14	55.95	42.8	40.6
50	18.94	46.75	55.3	27.1
60	12.97	37.25	65.1	18.1
70	7.81	28.25	77.0	9.4
90	1.21	12.25	87.2	4.2



## SOLUBILITY OF SODIUM NITRATE IN AQUEOUS ALCOHOL AT 25°.

(Armstrong and Eyre, 1910-11.)

Solvent.		Gms. NaNO <sub>3</sub> per 100 Gms. Sat. Sol.
Mols. C <sub>2</sub> H <sub>5</sub> OH per 1000 Gms. H <sub>2</sub> O.	Gms. C <sub>2</sub> H <sub>5</sub> OH per 1000 Gms. H <sub>2</sub> O.	
0	0	47.93
0.25	11.51	47.32
0.50	23.03	46.73
1	46.06	45.43
2	92.12	43.04

## SOLUBILITY OF SODIUM NITRATE IN AQUEOUS SOLUTIONS OF ACETONE.

Results at 30°.

(Taylor, 1897.)

Results at 40°.

(Bathrick, 1896.)

Wt. per cent Acetone in Solvent.	Gms. NaNO <sub>3</sub> per 100 Gms.		Wt. per cent Acetone.	Gms. NaNO <sub>3</sub> per 100 Gms. Aq. Acetone.
	Solution.	Water.		
0	49.10	96.45	0.0	105
5	46.96	93.20	8.47	91.2
9.09	45.11	90.40	16.8	78.3
20	40.10	83.70	25.2	66.4
30	35.08	77.20	34.3	57.9
40	29.80	70.75	44.1	46.2
50	24.34	64.40	53.9	32.8
60	18.55	59.95	64.8	23.0
70	13.15	50.50	76.0	10.8
80	7.10	38.20	87.6	3.2
90	1.08	20.20		

gms. hydroxylamine dissolve 13.1 gms. NaNO<sub>3</sub> at 17-18°. (de Bruyn, 1892.)c. anhydrous hydrazine dissolve 100 gms. NaNO<sub>3</sub> at room temp.

(Welsh and Broderson, 1915.)

m-point data for NaNO<sub>3</sub> + NaNO<sub>2</sub> are given by Bruni and Meneghini (1910).Data for NaNO<sub>3</sub> + SrNO<sub>3</sub> + KNO<sub>3</sub> are given by Harkins and Clark (1915)data for NaNO<sub>3</sub> + TiNO<sub>3</sub> by van Eyk (1905).SODIUM NITRITE NaNO<sub>2</sub>.

## SOLUBILITY IN WATER.

(Oswald, 1912, 1914.)

t°.	Gms. NaNO <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. NaNO <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.
15	9.1	Ice	30	47.8	NaNO <sub>2</sub>
	23.8	"	40	49.6	"
25	29.6	"	52.5	51.4	"
35 Eutec.	39.7	" + NaNO <sub>2</sub>	65	54.6	"
	40.8	NaNO <sub>2</sub>	81	57.9	"
	41.9	"	92	59.7	"
	43.8	"	103	62.6	"
	45.8 (d = 1.3585)	"	128	68.7	"

gms. H<sub>2</sub>O dissolve 83.3 gms. NaNO<sub>2</sub> at 15°.

(Divers, 1899.)

gms. H<sub>2</sub>O dissolve 83.25 gms. NaNO<sub>2</sub> at 15°.

(v. Niementowski and v. Roszkowski, 1897.)

gms. H<sub>2</sub>O dissolve 73.5 gms. NaNO<sub>2</sub> at 15°, d<sub>15</sub> = 1.3476.

(Greenish and Smith, 1907.)



# SODIUM NITRITE

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## SOLUBILITY OF SODIUM NITRITE IN AQUEOUS SOLUTIONS OF SODIUM NITRATE AND VICE VERSA AT SEVERAL TEMPERATURES.

(Oswald, 1912, 1914.)

Results at 0°.		Results at 21°.		Results at 52°.		Results at 103°.	
Gms. per 100 Gms. H <sub>2</sub> O.	NaNO <sub>2</sub> .	Gms. per 100 Gms. H <sub>2</sub> O.	NaNO <sub>2</sub> .	Gms. per 100 Gms. H <sub>2</sub> O.	NaNO <sub>2</sub> .	Gms. per 100 Gms. H <sub>2</sub> O.	NaNO <sub>2</sub> .
73	0	84.75	0	108.8	0	166	0
68	19	81.1	9.6	104.3	20.6	153.3	33.2
67	36.3	79.7	23.5	99.5	43.2	148.8	58.8
64.9	41.7*	73.8	50.8	98.8	82 *	142.4	116
50.3	46.8	73.1	54.5*	65.2	88	100	126
30.2	55.4	64.2	56.7	44.2	92.9	60.1	142
0	74.2	46.8	62.8	27.2	101.4	0	181
		21.6	74.7	14.7	109		
		0	89.3	0	118		

\* Both salts in solid phase.

Similar results are also given for 18°, 65°, 81° and 92°.

100 gms. H<sub>2</sub>O, simultaneously saturated with both salts, contain 53.9 NaNO<sub>2</sub> + 11.8 gms. Na<sub>2</sub>SO<sub>4</sub> at 16°.

(Oswald,

## SOLUBILITY OF MIXTURES OF SODIUM NITRITE AND SILVER NITRITE IN WATER AT 14° AND AT 22°.

(Oswald, 1912, 1914.)

Results at 14°.		Results at 22°.		Solid Phase in Each Case.
Gms. per 100 Gms. H <sub>2</sub> O.	AgNO <sub>2</sub> .	Gms. per 100 Gms. H <sub>2</sub> O.	AgNO <sub>2</sub> .	
55	15.2	58.3	21.5	AgNO <sub>2</sub> + Na <sub>2</sub> Ag <sub>2</sub> (NO <sub>2</sub> ) <sub>4</sub> .H <sub>2</sub> O
74.7	11.3	78.3	13.4	NaNO <sub>2</sub> + Na <sub>2</sub> Ag <sub>2</sub> (NO <sub>2</sub> ) <sub>4</sub> .H <sub>2</sub> O

100 gms. abs. methyl alcohol dissolve 4.43 gms. NaNO<sub>2</sub> at 19.5°.

100 gms. abs. ethyl alcohol dissolve 0.31 gm. NaNO<sub>2</sub> at 19.5°. (de Bruyn, 1892.)

## SODIUM RHODONITRITE Na<sub>4</sub>Rh<sub>2</sub>(NO<sub>2</sub>)<sub>12</sub>.

100 gms. H<sub>2</sub>O dissolve 40 gms. at 17°, and 100 gms. at 100°.

(Leidic, 1890.)

## SODIUM OLEATE C<sub>17</sub>H<sub>33</sub>CH:CH(CH<sub>2</sub>)<sub>7</sub>COONa.

### SOLUBILITY IN WATER AND AQUEOUS BILE SALTS.

(Moore, Wilson and Hutchinson, 1909.)

Solvent.	Gms. Oleate per 100 Gms. Sat. Sol.
Water	5
Aq. 5% Bile Salts	7.6
Aq. 5% Bile Salts + 1% Lecithin	11.6

## SODIUM OXALATE Na<sub>2</sub>C<sub>2</sub>O<sub>4</sub>.

### SOLUBILITY IN WATER.

(Souhay and Leussen, 1856; Pohl, 1852.)

t°.	15.5°.	21.8°.	100°.
Gms. Na <sub>2</sub> C <sub>2</sub> O <sub>4</sub> per 100 gms. H <sub>2</sub> O	3.22	3.74	6.33

100 gms. sat. solution of sodium oxalate in water contain 3.09 gms. Na<sub>2</sub>C<sub>2</sub>O<sub>4</sub> at 15° and 4.28 gms. at 50°.

(Colani, 1916.)

100 gms. 95% formic acid dissolve 8.8 gms. Na<sub>2</sub>C<sub>2</sub>O<sub>4</sub> at 19.3°.

(Aschan, 1911.)



**M OXALATE**

STABILITY OF MIXTURES OF SODIUM OXALATE AND OXALIC ACID IN WATER AT 25°. (Foote and Andrew, 1905.)

Gms. per 100 Gms. Solution.		Mols. per 100 Mols. H <sub>2</sub> O.		Solid Phase.
$\text{H}_2\text{C}_2\text{O}_4$ .	$\text{Na}_2\text{C}_2\text{O}_4$ .	$\text{H}_2\text{C}_2\text{O}_4$ .	$\text{Na}_2\text{C}_2\text{O}_4$ .	
10.20	...	2.274	...	$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$
10.50	0.83	2.370	0.130	$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O} + \text{HNaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$
9.15	0.71	2.032	0.106	Double Salt, $\text{HNaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$
6.88	0.86	1.493	0.125	
1.14	1.25	0.234	0.172	
0.47	3.20	0.098	0.446	
0.42	3.85	0.090	0.541	$\text{HNaC}_2\text{O}_4 \cdot \text{H}_2\text{O} + \text{Na}_2\text{C}_2\text{O}_4$
...	3.60	...	0.502	$\text{Na}_2\text{C}_2\text{O}_4$

SOLUBILITY OF MIXTURES OF SODIUM OXALATE AND OTHER SODIUM SALTS IN WATER AT 15° AND AT 50°. (Colani, 1916.)

Gms. per 100 Gms. Sat. Solution.		Solid Phase.
$\text{Na}_2\text{C}_2\text{O}_4$ .	$\text{NaCl}$ .	
0.027	+ 26.28	$\text{Na}_2\text{C}_2\text{O}_4 + \text{NaCl}$
0.063	+ 26.64	" + "
0.86	+ 10.26	$\text{Na}_2\text{C}_2\text{O}_4 + \text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
0.22	+ 31.95	" + $\text{Na}_2\text{SO}_4$
0.051	+ 45.86	$\text{Na}_2\text{C}_2\text{O}_4 + \text{NaNO}_3$
0.047	+ 53.06	" + "

EQUILIBRIUM IN THE SYSTEM SODIUM OXALATE, URANYL OXALATE AND WATER AT 15° AND 50°. (Colani, 1917.)

Results at 15°.		Results at 50°.		
er 100 Gms. at. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.	
$\text{UO}_2\text{C}_2\text{O}_4$ .		$\text{Na}_2\text{C}_2\text{O}_4$ .	$\text{UO}_2\text{C}_2\text{O}_4$ .	
0	$\text{Na}_2\text{C}_2\text{O}_4$	4.28	0	$\text{Na}_2\text{C}_2\text{O}_4$
3.14	" + 2.1.2.5	9.03	13.09	" + 2.1.2.5
5.01	2.1.2.5 + 2.4.5.11	4.62	12.33	2.1.2.5 + 2.2.3.5
2.65	2.4.5.11 + $\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$	3.60	9.84	2.2.3.5 + 2.4.5.11
0.47	$\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$	1.01	3.58	2.4.5.11 + $\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$
		0	1	$\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$

$= \text{Na}_2(\text{UO}_2)(\text{C}_2\text{O}_4)_2 \cdot 5\text{H}_2\text{O}$ ,  $2.2.3.5 = \text{Na}_2(\text{UO}_2)_2(\text{C}_2\text{O}_4)_3 \cdot 5\text{H}_2\text{O}$ ,  $2.4.5.11 = (\text{UO}_2)_4(\text{C}_2\text{O}_4)_5 \cdot 11\text{H}_2\text{O}$ .

**M PALMITATE**  $\text{CH}_3(\text{CH}_2)_{14}\text{COONa}$ .

ms. sat. solution in  $\text{H}_2\text{O}$  contain 0.2 gm. sodium palmitate.

ms. sat. solution in 5% aq. bile salts contain 1 gm. sodium palmitate.

ms. sat. solution in 5% aq. bile salts + 1% lecithin contain 2.4 gms. palmitate. (Moore, Wilson and Hutchinson, 1909.)

SOLUBILITY OF SODIUM PALMITATE IN PALMITIC ACID. (Donnan and White, 1911.)

Gms. Na Palmitate per 100 Gms. Liquid Phase.	Gms. Na Palmitate per 100 Gms. Solid Phase (Na Palmitate + Palmitic Acid).	t°.	Gms. Na Palmitate per 100 Gms. Liquid Phase.	Gms. Na Palmitate per 100 Gms. Solid Phase (Na Palmitate + Palmitic Acid).
2.3	0.7	71	22.60	25.38
4.96	11.12	72.9	28.65	35.05
7.98	13.78	73.5	29.07	35.23
12.28	16.36	76	30.7	35.9
13.72	18.70	79.2	33.36	35.66
15.56	26.55	82	36.02	39.64

solid phases form three series of solid solutions.

special apparatus was devised for preparing the saturated solutions and filtering the solid phases.



# SODIUM PHENOLATE

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## SODIUM *p* NITROPHENOL $C_6H_4ONa(1).NO_2(4)$ .

SOLUBILITY IN WATER AND IN AQUEOUS NORMAL SOLUTIONS OF NON-ELECTROLYTES.  
(Goldschmidt, 1895.)

t°.	Gms. $C_6H_4ONa(1).NO_2(4)$ per 100 Gms. Solution in:							
	Water.	Alcohol.	Urea.	Glycerine.	Acetone.	Propionitril.	Acetonitril.	Urethane.
23.7	5.597	5.615	6.244	6.188	6.225	6.257	6.065	6.520
28.6	6.721	6.874	7.489	7.440	7.498	7.571	7.328	7.889
30.6	7.256	...	...	...	...	...	...	...
33.6	8.125	8.318	9.000	9.025	9.025	9.066	8.886	9.507
35.9	8.851	...	...	...	...	...	...	...
36.1	8.883	...	9.683	9.688	9.665	9.911	9.667	10.248
40.2	9.881	10.147	10.666	10.777	10.695	10.905	10.667	11.379
45.2	11.235	11.513	12.068	12.229	...	...	...	12.869
50.1	12.730	13.133	13.555	13.785	...	...	...	...

The solid phase is  $C_6H_4ONa.NO_2.4H_2O$  below 36°, and  $C_6H_4ONa.NO_2.2H_2O$  above 36° in each case.

## SODIUM PHOSPHATE (Ortho) $Na_3PO_4.12H_2O$ .

SOLUBILITY IN WATER.  
(Mulder).

t°.	Gms. per 100 Gms. $H_2O$ .	t°.	Gms. per 100 Gms. $H_2O$ .	t°.	Gms. per 100 Gms. $H_2O$ .
0	1.5	25	15.5	60	55
10	4.1	30	20	80	81
20	11	40	31	100	108
		50	43		

## SODIUM Hydrogen PHOSPHATE $Na_2HPO_4.12H_2O$ .

SOLUBILITY IN WATER.  
(Shiomi, 1908; Menzies and Humphrey, 1912.)

t°.	Gms. $Na_2HPO_4$ per 100 Gms. $H_2O$ .	Solid Phase.	t°.	Gms. $Na_2HPO_4$ per 100 Gms. $H_2O$ .	Solid Phase.
- 0.43	1.42	Ice	45	67.3	$Na_2HPO_4.7H_2O$
- 0.24	0.70	"	47.23	76.58 (S)	"
- 0.5 Eutec.	...	" + $Na_2HPO_4.12H_2O$	48.3 tr. pt.	...	{ $Na_2HPO_4.7H_2O$ + $Na_2HPO_4.12H_2O$
+ 0.05	1.67	$Na_2HPO_4.12H_2O$	48	...	(S) { $Na_2HPO_4.7H_2O$ + $Na_2HPO_4.12H_2O$
10.26	3.55 (S)	"	50	80.2	$Na_2HPO_4.12H_2O$
15.11	5.23 (S)	"	55.17	81.4 (S)	"
20	7.66	"	60	82.9	"
25	12	"	70.26	88.11 (S)	"
30.21	20.81 (S)	"	80	92.4	"
30.76	23.41 (S)	"	89.74	102.87 (S)	"
32	25.7	"	90.2	101.1	"
33.04	30.88 (S)	"	95 tr. pt.	...	" + $Na_2HPO_4$
34	33.8	"	95.2	...	(S) " "
35.2 tr. pt.	...	" + $Na_2HPO_4.7H_2O$	96.2	104.6	$Na_2HPO_4$
36.45	... (S)	"	99.77	102.15 (S)	"
37.27	47.51 (S)	$Na_2HPO_4.7H_2O$	105	103.3	"
39.2	51.8	"	120	99.2	"

Results marked (S) by Shiomi, all others by Menzies and Humphrey.

100 gms.  $H_2O$  dissolve 12.2 gms.  $Na_2HPO_4$  at 25°, determined by refractomete

(Osaka, 1903-8)

100 gms.  $H_2O$  dissolve 5.23 gms.  $Na_2HPO_4$  at 15°,  $d_{15} = 1.049$ . (Greenish and Smith, 1901)

100 gms. alcohol of  $d_{15} = 0.941$  dissolve 0.33 gm.  $Na_2HPO_4$  at 15.5°.



**III Dihydrogen PHOSPHATE  $\text{NaH}_2\text{PO}_4$ .****SOLUBILITY IN WATER.**

(Imadsu, 1911-12.)

Gms. $\text{NaH}_2\text{PO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{NaH}_2\text{PO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
57.86	$\text{NaH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$	45	148.20	$\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$
63.82	"	50	158.61	"
69.87	"	55	170.85	"
76.72	"	57	175.81	"
85.21	"	57.4 tr. pt.	...	" + $\text{NaH}_2\text{PO}_4$
94.63	"	60	179.33	$\text{NaH}_2\text{PO}_4$
106.45	"	65	184.99	"
120.44	"	69	190.24	"
138.16	"	80	207.29	"
tr. pt. ...	" + $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$	90	225.31	"
142.55	$\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$	99.1	246.56	"

**IV Acid PHOSPHATE  $\text{NaH}_2\text{PO}_4 \cdot \text{H}_3\text{PO}_4$ .****SOLUBILITY IN WATER AND IN ANHYDROUS PHOSPHORIC ACID, DETERMINED BY THE SYNTHETIC METHOD.**

(Parravano and Mieli, 1908.)

Solubility in Water.			Solubility in $\text{H}_3\text{PO}_4$ .		
Gms. $\text{NaH}_2\text{PO}_4 \cdot \text{H}_3\text{PO}_4$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{NaH}_2\text{PO}_4 \cdot \text{H}_3\text{PO}_4$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.
20.77	Ice	79.7	87.48	$\text{NaH}_2\text{PO}_4$	98.5
26.92	"	85	88.65	"	111
34.15	"	101.7	91.47	" + $\text{NaH}_2\text{PO}_4 \cdot \text{H}_3\text{PO}_4$	119
56.66	"	104.5	92.67	$\text{NaH}_2\text{PO}_4 \cdot \text{H}_3\text{PO}_4$	122
80.46	$\text{NaH}_2\text{PO}_4$	110	95.79	"	123
81.82	"	119	97.99	"	
83.68	"	126.5	100	"	m. pt. of the $\text{H}_3\text{PO}_4 = 40.6^\circ$

are also given for the fusion points of  $\text{NaH}_2\text{PO}_4 + \text{H}_3\text{PO}_4$ .m-point data for mixtures of  $\text{NaPO}_3 + \text{Na}_4\text{P}_2\text{O}_7$  are given by Parravano and Mieli (1908, 1910.)**EQUILIBRIUM IN THE SYSTEM SODIUM HYDROXIDE, PHOSPHORIC ACID AND WATER AT  $25^\circ$ .**

(D'Ans and Schreiner, 1910a.)

per 1000 Gms. Sol.		Solid Phase.	Mols. per 1000 Gms. Sol.		Solid Phase.
$\text{PO}_4$ .			Na.	$\text{PO}_4$ .	
...		$\text{NaOH} \cdot \text{H}_2\text{O}$	6.76	4.88	$\text{Na}_2\text{HPO}_4 \cdot 7\text{H}_2\text{O}$
0.040		$\text{Na}_2\text{PO}_4 \cdot 12\text{H}_2\text{O}$	7.31	5.55	" unstable
0.183		"	6.76	4.88	" + $\text{Na}_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$
0.752		"	6.19	4.68	$\text{Na}_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$
1.08		"	6.01	4.67	"
1.33	$\text{Na}_2\text{PO}_4 \cdot 12\text{H}_2\text{O} + \text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$		5.12	4.36	"
1.09	$\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$		4.81	4.22	"
0.78	"		4.36	4.08	"
1.60	"		4.06	4.03	"
2.24	"		4.19	4.38	"
3.55	"		4.32	4.96	"
3.87	"		4.65	5.89	"
4.63	$\text{Na}_2\text{HPO}_4 \cdot 7\text{H}_2\text{O}$		4.88	6.40	"



# SODIUM PHOSPHATES

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## SODIUM PyroPHOSPHATE $\text{Na}_4\text{P}_2\text{O}_7 \cdot 10\text{H}_2\text{O}$ .

### SOLUBILITY IN WATER. (Mulder; Poggiale.)

t°.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .
0	3.16	25	8.14	60	21.83
10	3.95	30	9.95	80	30.04
20	6.23	40	13.50	100	40.26
		50	17.45		

## SODIUM PyroPHOSPHATES.

### SOLUBILITY IN WATER. (Giran, 1903a.)

Salt.	Formula.	t°.	Gms. Anhydrous Salt per 100 cc. Sat. Sol.
Monosodium Pyrophosphate	$\text{NaH}_2\text{P}_2\text{O}_7$	18	62.7
Disodium Pyrophosphate	$\text{Na}_2\text{H}_2\text{P}_2\text{O}_7 \cdot 6\text{H}_2\text{O}$	18	14.95
Trisodium Pyrophosphate	$\text{Na}_3\text{HP}_2\text{O}_7 \cdot 6\text{H}_2\text{O}$	18	28.17

## SODIUM PHOSPHITES

### SOLUBILITY OF SODIUM PHOSPHITES, ETC., IN WATER.

Salt.	Formula.	t°.	Gms. Salt per 100 Gms. $\text{H}_2\text{O}$ .	Authority.
Hydrogen Phosphite	$(\text{NaH})\text{HPO}_2 \cdot 2\frac{1}{2}\text{H}_2\text{O}$	0	56	} (Amat. — Compl. remd. 106, 135, 14)
"	"	10	66	
"	"	42	193	
Hypophosphate	$\text{Na}_4\text{P}_2\text{O}_6 \cdot 10\text{H}_2\text{O}$	cold	3.3	} (Salser — Liebig's Ann. 214, 4, 16)
Hydrogen Hypophosphate	$\text{Na}_2\text{HP}_2\text{O}_6 \cdot 9\text{H}_2\text{O}$	?	4.5	
Tri Hydrogen	$\text{NaH}_2\text{P}_2\text{O}_6 \cdot 3\text{H}_2\text{O}$	cold	6.7	
Di Hydrogen	$\text{Na}_2\text{H}_2\text{P}_2\text{O}_6 \cdot 6\text{H}_2\text{O}$	cold	2.2	} (Salser — Liebig's Ann. 187, 331, 17) (U. S. P.)
Di Hydrogen	$\text{Na}_2\text{H}_2\text{P}_2\text{O}_6 \cdot 6\text{H}_2\text{O}$	b. pt.	20.0	
Hypophosphite	$(\text{NaH})\text{HPO}_2 \cdot \text{H}_2\text{O}$	25	100.0	
Hypophosphite	$(\text{NaH})\text{HPO}_2 \cdot \text{H}_2\text{O}$	b. pt.	830	

100 gms.  $\text{H}_2\text{O}$  dissolve 108.7 gms. anhydrous sodium hypophosphite ( $\text{NaH}_2\text{PO}_2$ ) at 15°, d<sub>15</sub> of sat. sol. = 1.388. (Greenish and Smith, 1901.)

## SODIUM (Double) PHOSPHATE, FLUORIDE $\text{Na}_2\text{PO}_4 \cdot \text{NaF} \cdot 12\text{H}_2\text{O}$ .

100 gms. water dissolve 12 gms. of the double sodium salt at 25°, and 57.5 gms. at 70°. Sp. Gr. of solution at 25° = 1.0329; at 70° = 1.1091. (Briegleb, 1896.)

## SODIUM PICRATE $\text{C}_6\text{H}_3(\text{NO}_2)_3 \cdot \text{ONa} \cdot \text{H}_2\text{O}$ .

### SOLUBILITY IN WATER AND IN AQUEOUS SOLUTIONS AT 25°. (Fisher and Miloszewski, 1910.)

100 cc.  $\text{H}_2\text{O}$  dissolve 4.247 gms.  $\text{C}_6\text{H}_3(\text{NO}_2)_3 \cdot \text{ONa} \cdot \text{H}_2\text{O}$  at 25°.

Solubility in Aq. Solution of:	Gms. $\text{C}_6\text{H}_3(\text{NO}_2)_3 \cdot \text{ONa} \cdot \text{H}_2\text{O}$ per 100 cc. Aq. Solution of Normality:							
	0.01.	0.02.	0.04.	0.066.	0.10.	0.25.	0.5.	1.
$\text{Na}_2\text{CO}_3$	4.159	4.044	3.807	3.434	3.187	2.017	1.120	0.611
$\text{NaCl}$	4.189	3.956	3.677	3.335	3.021	1.678	0.846	0.410
$\text{Na}_2\text{SO}_4$	4.246	4.102	3.879	3.651	3.195	2.053	1.156	0.552
$\text{Na}_3\text{PO}_4$	4.235	4.051	3.814	3.562	3.225	2.219	1.329	0.705
$\text{NaOH}$	4.192	4.048	3.715	3.339	2.941	1.781	0.921	0.371
$\text{NaNO}_3$	4.154	4.029	3.710	3.363	3.041	1.932	0.943	0.684
$\text{NaBr}$	4.190	4.117	3.770	3.384	3.024	1.777	0.912	0.499

Data for the solubility of sodium picrate and the sodium salts of other nitrophenols in aqueous alcohol and acetone solutions at 25° are given by Fisher (1914).



**SODIUM SALICYLATE**  $C_6H_4.OH.COONa$ .

SOLUBILITY IN AQUEOUS ETHYL ALCOHOL AT 25°. (Seidell, 1909, 1910.)

Per cent OH in Solv.	$d_{20}$ of Sat. Sol.	Gms. $C_6H_4.OH$ - $COONa$ per 100 Gms. Sat. Sol.	Wt. Per cent $C_6H_4.OH$ in Solvent.	$d_{20}$ of Sat. Sol.	Gms. $C_6H_4.OH$ - $COONa$ per 100 Gms. Sat. Sol.
0	1.256	53.56	60	1.066	38.40
10	1.235	52.10	70	1.016	33
20	1.205	50.20	80	0.957	25
30	1.176	48	90	0.885	15
40	1.142	45.50	92.3	0.864	12
50	1.106	42.20	100	0.805	3.82

20 gms. sat. solution in water contain 51.8 gms.  $C_6H_4.OH.COONa$  at 15° and the sat. sol. is 1.249. (Greenish and Smith, 1901.) See also last line of first table.

0 gms. propyl alcohol dissolve 1.16 gms.  $C_6H_4.OH.COONa$  at ord. temp.

(Schlamp, 1894.)

Sodium salicylate distributes itself between olive oil and water at 15° in the ratio of 0.156 gm.  $C_6H_4.OH.COONa$  per 100 cc. oil layer and 1.444 gms. per 100 cc. aqueous layer.

(Harriss, 1903.)

**SODIUM SELENATE**  $Na_2SeO_4.10H_2O$ .

SOLUBILITY IN WATER. (Funk, 1900a.)

Gms. $Na_2SeO_4$ per 100 Gms. Solution.	Mols. $Na_2SeO_4$ per 100 Mols. $H_2O$ .	Solid Phase.	t°	Gms. $Na_2SeO_4$ per 100 Gms. Solution.	Mols. $Na_2SeO_4$ per 100 Mols. $H_2O$ .	Solid Phase.
11.74	1.26	$Na_2SeO_4.10H_2O$	35.2	45.47	7.94	$Na_2SeO_4$
25.01	3.18	"	39.5	45.26	7.87	"
29.00	3.90	"	50	44.49	7.63	"
36.91	5.57	"	75	42.83	7.14	"
39.18	6.13	"	100	42.14	6.93	"
44.05	7.50	"				

p. Gr. of saturated solution at 18° = 1.315.

**SODIUM SILICATE**  $Na_2SiO_3.9H_2O$ .

SOLUBILITY IN AQUEOUS SODIUM HYDROXIDE AND SODIUM CHLORIDE SOLUTIONS. (Vesterberg, 1912.)

Solvent.	t°.	$d_{17}$ of Sat. Sol.	Gms. per 100 cc. Sat. Solution.			
			$Na_2O$ .	$SiO_2$ = $Na_2SiO_3.9H_2O$ .	$NaCl$ .	
prox. 0.5% $NaOH$	17.5	1.129	6.942	5.419 = 25.56	...	
" " $NaCl$	17.5	1.150	7.347	7.172 = 33.83	2.297	
Saturated $NaCl$ Solution	19	1.258	4.563	4.376 = 20.64	27.91	

Solid phase  $Na_2SiO_3.9H_2O$  in each case.

Intersection-point data for  $Na_2SiO_3 + SrSiO_3$  are given by Wallace (1909). Results for  $Na_2SiO_3 + Na_2WO_4$  are given by van Klooster (1910-11).

**SODIUM STANNATE**  $Na_2SnO_3.3H_2O$ .

10 gms.  $H_2O$  dissolve 67.4 gms. at 0°, and 61.3 gms. at 20°. Sp. Gr. of solution = 1.472; at 20° = 1.438.

(Ordway, 1865.)

**SODIUM SUCCINATE**  $(CH_2)_2(COONa)_2.6H_2O$ .

SOLUBILITY IN WATER. (Marshall and Bain, 1910.)

Gms. $(CH_2)_2$ - $(COONa)_2$ per 100 Gms. $H_2O$ .	Solid Phase.	t°.	Gms. $(CH_2)_2$ - $(COONa)_2$ per 100 Gms. $H_2O$ .	Solid Phase.
21.45	$(CH_2)_2(COONa)_2.6H_2O$	50	56.3	$(CH_2)_2(COONa)_2.6H_2O$
5 27.38	"	62.5	78.49	"
34.90	"	64.9	83.38	" + $(CH_2)_2(COONa)_2$
5 43.64	"	75	86.63	$(CH_2)_2(COONa)_2$



SOLUBILITY OF SODIUM HYDROGEN SUCCINATE IN WATER.  
 (Marshall and Bain, 1910.)

t°.	Gms. (CH <sub>2</sub> ) <sub>2</sub> - (COOH)(COONa) per 100 Gms. H <sub>2</sub> O.	Solid Phase.	t°.	Gms. (CH <sub>2</sub> ) <sub>2</sub> - (COOH)(COONa) per 100 Gms. H <sub>2</sub> O.	Solid Phase.
0	17.55	NaHSu·3H <sub>2</sub> O	38.7	63.99	NaHSu·3H <sub>2</sub> O
2.5	27.93	"	50	67.37	NaHSu·3H <sub>2</sub> O
25	39.82	"	62.5	76.15	"
37.5	60.01	"	75	86	"

 EQUILIBRIUM IN THE SYSTEM SODIUM SUCCINATE, SUCCINIC ACID AND  
 (Marshall and Bain, 1910.)

Results at 0°.			Results at 25°.		
Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
Na <sub>2</sub> Su.	H <sub>2</sub> Su.		Na <sub>2</sub> Su.	H <sub>2</sub> Su.	
0	2.68	H <sub>2</sub> Su*	0	7.71	H <sub>2</sub> Su
3.23	4.76	"	3.68	10.26	"
5.38	5.83	"	8.99	13.35	"
8.27	7.12	" + NaHSu·3H <sub>2</sub> O	12.64	15.53	"
8.67	6.27	NaHSu·3H <sub>2</sub> O	15.26	16.90	" + NaHSu·3H <sub>2</sub> O
9.68	4.74	"	15.97	13.83	NaHSu·3H <sub>2</sub> O
11.74	3.49	"	18.89	8.41	"
15.62	2.34	"	22.71	5.65	"
18.36	1.90	" + Na <sub>2</sub> Su·6H <sub>2</sub> O	26.88	4.08	" + Na <sub>2</sub> Su·6H <sub>2</sub> O
18.07	1.67	Na <sub>2</sub> Su·6H <sub>2</sub> O	26.50	2.38	Na <sub>2</sub> Su·6H <sub>2</sub> O
17.87	0.94	"	26.11	0.85	"
17.64	...	"	25.87	0	"
Results at 50°.			Results at 75°.		
0	19.27	H <sub>2</sub> Su*	0	37.64	H <sub>2</sub> Su
5.95	22.90	"	8.22	40.38	"
10.25	25.33	"	13.14	42.50	"
15.49	28.73	"	16.93	44.38	"
19.65	31.73	" + NaHSu	19.56	45.98	" + NaHSu
20.72	26.51	NaHSu	21.88	35.60	NaHSu
22.53	18.44	"	24.30	26.82	"
25.53	13.09	"	29.45	15.28	"
28.28	9.46	"	36.11	7.79	"
30.48	7.38	"	41.26	4.93	"
37.33	4.20	" + Na <sub>2</sub> Su·6H <sub>2</sub> O	45.27	4	" + Na <sub>2</sub> Su·6H <sub>2</sub> O
36.85	3.88	Na <sub>2</sub> Su·6H <sub>2</sub> O	45.36	3.17	Na <sub>2</sub> Su·6H <sub>2</sub> O
36.67	2.66	"	45.93	1.23	"
36.43	0	"	46.42	0	"

The following double and triple points were located:

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	Na <sub>2</sub> Su.	H <sub>2</sub> Su.	
34.9	30.8	5.6	NaHSu.3H <sub>2</sub> O+NaHSu+Na <sub>2</sub> Su.6H <sub>2</sub> O
37.8	19.6	25.46	NaHSu.3H <sub>2</sub> O+NaHSu+H <sub>2</sub> Su
38.7	22.47	16.44	NaHSu.3H <sub>2</sub> O+NaHSu
63.4	42.92	3.64	Na <sub>2</sub> Su.6H <sub>2</sub> O+Na <sub>2</sub> Su.H <sub>2</sub> O+NaHSu
64.9	45.43	...	Na <sub>2</sub> Su.6H <sub>2</sub> O+Na <sub>2</sub> Su.H <sub>2</sub> O

\* In the above tables the abbreviation Su is used for (CH<sub>2</sub>)<sub>2</sub>(COO)<sub>2</sub>.



DIUM SULFATE  $\text{Na}_2\text{SO}_4$ .

## SOLUBILITY IN WATER.

Mukder; Löwel, 1851; Tilden and Shenstone, 1883; Etard, 1894; Funk, 1900a; Berkeley, 1904.)

	Gms. $\text{Na}_2\text{SO}_4$ per 100 Gms.		Mols. $\text{Na}_2\text{SO}_4$ per Liter (B.).	Solid Phase.	$t^\circ$ .	Gms. $\text{Na}_2\text{SO}_4$ per 100 Gms.		Mols. $\text{Na}_2\text{SO}_4$ per Liter (B.).	Solid Phase.
	Solution.	Water.				Solution.	Water.		
	4.76	5.0	0.31	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$	50	31.8	46.7	2.92	$\text{Na}_2\text{SO}_4$
	6.0	6.4	...	"	60	31.2	45.3	2.83	"
	8.3	9.0	0.631	"	80	30.4	43.7	2.69	"
	11.8	13.4	...	"	100	29.8	42.5	2.60	"
	16.3	19.4	1.32	"	120	29.5	41.95	...	"
	21.9	28.0	...	"	140	29.6	42	...	"
5	25.6	34.0	...	"	160	30.7	44.25	...	"
	29.0	40.8	2.63	"	230	31.7	46.4	...	"
	30.6	44.0	...	"	0	16.3	19.5	...	$\text{Na}_2\text{SO}_4 \cdot 7\text{H}_2\text{O}$
	32.3	47.8	...	"	5	19.4	24	...	"
75	33.6	50.65	3.11	"	10	23.1	30	...	"
	33.6	50.6	...	$\text{Na}_2\text{SO}_4$	15	27.0	37	...	"
	33.4	50.2	...	"	20	30.6	44	...	"
	32.8	48.8	3.01	"	25	34.6	53	...	"

the very carefully determined values of Berkeley are as follows:

	$d_4$ of Sat. Sol.	Gms. $\text{Na}_2\text{SO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	$t^\circ$ .	$d_4$ of Sat. Sol.	Gms. $\text{Na}_2\text{SO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
70	1.0432	4.71	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$	32.5 tr. pt.	...	...	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O} + \text{Na}_2\text{SO}_4$
25	1.0802	9.21	"	33.5	1.3307	49.39	$\text{Na}_2\text{SO}_4$
55	1.1150	14.07	"	38.15	1.3229	48.47	"
35	1.1546	...	"	44.85	1.3136	47.49	"
30	1.2067	27.67	"	60.10	1.2918	45.22	"
55	1.2459	34.05	"	75.05	1.2728	43.59	"
20	1.2804	41.78	"	80.85	1.2571	42.67	"
35	1.3230	47.98	"	101.9*	1.2450	42.18	"

\* B. pt.

the following additional data at high temperatures, determined by the sealed tube method, are given by Wuite (1913-14).

Mol. Per cent $\text{Na}_2\text{SO}_4$ .	Gms. $\text{Na}_2\text{SO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	$t^\circ$ .	Mol. Per cent $\text{Na}_2\text{SO}_4$ .	Gms. $\text{Na}_2\text{SO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
5.39	44.92	$\text{Na}_2\text{SO}_4$ (rhombic)	208	5.39	44.92	$\text{Na}_2\text{SO}_4$ (rhombic)
5.27	43.87	"	235 tr. pt.	...	"	" + monoclinic
5.18	43.07	"	241	5.39	44.92	$\text{Na}_2\text{SO}_4$ (monoclinic)
5.04	41.84	"	250	5.04	41.84	"
5.255	43.74	"	279	4.12	33.84	"
5.27	43.87	"	319	2.56	20.71	"

persolubility curves for the ice phase,  $\text{Na}_2\text{SO}_4 \cdot 7\text{H}_2\text{O}$  phase and  $\text{Na}_2\text{SO}_4$  phase determined by Hartley, Jones and Hutchinson (1908) by agitating mixtures of sodium sulfate and water contained in sealed tubes, and noting the points at which spontaneous crystallization occurred while the tubes were gradually cooled. The effect of mechanical friction, produced by bits of glass, garnet, etc., was also noted.



# SODIUM SULFATE

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## SODIUM SULFATE

SOLUBILITY OF MIXTURES OF SODIUM SULFATE AND MAGNESIUM SULFATE  
IN WATER (ASTRAKANITE)  $\text{Na}_2\text{Mg}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$ .

(Roozeboom, 1887, 1888.)

t°.	Mols. per 100 Mols. $\text{H}_2\text{O}$ .		Grams per 100 Grams $\text{H}_2\text{O}$ .		Solid Phase.
	$\text{Na}_2\text{SO}_4$ .	$\text{MgSO}_4$ .	$\text{Na}_2\text{SO}_4$ .	$\text{MgSO}_4$ .	
22	2.95	4.70	23.3	31.4	Astrakanite
24.5	3.45	3.68	27.2	24.6	"
30	3.59	3.59	28.4	24.1	"
35	3.71	3.71	29.4	24.8	"
47	3.6	3.6	28.4	24.1	"
22	2.95	4.70	23.3	31.4	Astrakanite + $\text{Na}_2\text{SO}_4$
24.5	3.45	3.62	27.2	24.2	"
30	4.58	2.91	36.1	19.1	"
35	4.3	2.76	33.9	18.44	"
18.5	3.41	4.27	43.0	45.5	Astrakanite + $\text{MgSO}_4$
22	2.85	4.63	35.2	48.9	"
24.5	2.68	4.76	32.5	50.3	"
30	2.3	5.31	25.9	55.0	"
35	1.73	5.88	23.5	59.4	"

## SOLUBILITY OF MIXTURES OF SODIUM SULFATE, POTASSIUM CHLORIDE, POTASSIUM SULFATE, ETC., IN WATER.

(Meyerhoffer and Saunders, 1899.)

t°.	Sp. Gr. of Solutions.	Mols. per 1000 Mols. $\text{H}_2\text{O}$ .				Solid Phase.
		$\text{SO}_4$	$\text{K}_2$	$\text{Na}_2$	$\text{Cl}_2$	
*4.4	...	5.42	14.39	51.83	60.8	$\text{K}_2\text{Na}(\text{SO}_4)_2 + \text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O} + \text{KCl} + \text{NaCl}$
0.2	...	3.35	12.78	50.93	60.36	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O} + \text{KCl} + \text{NaCl}$
-0.4	...	3.59	16.38	40.75	53.54	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O} + \text{KCl} + \text{K}_2\text{Na}(\text{SO}_4)_2$
16.3	...	4.72	17.58	50.56	63.42	$\text{K}_2\text{Na}(\text{SO}_4)_2 + \text{KCl} + \text{NaCl}$
24.8	1.2484	4.37	20.00	48.36	64.01	$\text{K}_2\text{Na}(\text{SO}_4)_2 + \text{KCl} + \text{NaCl}$
*16.3	...	16.29	9.16	61.06	53.93	$\text{K}_2\text{Na}(\text{SO}_4)_2 + \text{NaCl} + \text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
24.5	1.2625	14.45	9.90	58.46	53.91	$\text{K}_2\text{Na}(\text{SO}_4)_2 + \text{NaCl} + \text{Na}_2\text{SO}_4$
0.3	...	2.75	25.77	17.93	40.95	$\text{K}_2\text{Na}(\text{SO}_4)_2 + \text{KCl} + \text{K}_2\text{SO}_4$
25.0	1.2034	2.94	36.20	14.80	48.06	$\text{K}_2\text{Na}(\text{SO}_4)_2 + \text{KCl} + \text{K}_2\text{SO}_4$
*17.9	1.2474	13.84	0.0	62.57	48.70	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O} + \text{Na}_2\text{SO}_4 + \text{NaCl}$
*30.1	1.2890	50.41	10.08	40.33	0.0	$\text{K}_2\text{Na}(\text{SO}_4)_2 + \text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O} + \text{NaCl}$
-21.4	...	...	...	46.61	46.36	$\text{NaCl} \cdot 2\text{H}_2\text{O} + \text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
-23.7	...	...	10.51	39.58	50.09	$\text{NaCl} \cdot 2\text{H}_2\text{O} + \text{KCl}$
-10.9	...	1.45	30.68	...	29.23	$\text{KCl} + \text{K}_2\text{SO}_4$
-3	...	16.25	10.03	6.21	...	$\text{K}_2\text{Na}(\text{SO}_4)_2 + \text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
-3	...	16.24	10.03	6.21	...	$\text{K}_2\text{Na}(\text{SO}_4)_2 + \text{K}_2\text{SO}_4$
-14	...	1.39	25.59	8.78	32.94	$\text{K}_2\text{Na}(\text{SO}_4)_2 + \text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
-14	...	1.39	25.59	8.78	32.94	$\text{K}_2\text{Na}(\text{SO}_4)_2 + \text{K}_2\text{SO}_4 + \text{KCl}$
-23.3	...	0.41	15.15	44.20	58.97	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O} + \text{KCl} + \text{NaCl}$

\* Indicates transition points.



OLUBILITY OF SODIUM SULFATE IN AQUEOUS SOLUTIONS OF SODIUM  
ACETATE AT 25°.

(Fox, 1909.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
NaOAc.	Na <sub>2</sub> SO <sub>4</sub> .		CH <sub>3</sub> COONa.	Na <sub>2</sub> SO <sub>4</sub> .	
	21.9	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O	12.58	13.50	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O
10	17.72	"	16.26	11.50	"
71	16.48	"	20.68	8.10	"

OLUBILITY OF SODIUM SULFATE IN AQUEOUS SODIUM CHLORIDE AT 15°.

((Schreinemakers and de Baat, 1909.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
NaCl.	Na <sub>2</sub> SO <sub>4</sub> .		NaCl.	Na <sub>2</sub> SO <sub>4</sub> .	
42	7.86	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O	21.03	5.26	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O
51	5.87	"	23.39	5.64	" + NaCl
97	5.23	"	25.21	2.26	NaCl

OLUBILITY OF SODIUM SULFATE IN AQUEOUS SOLUTIONS OF SODIUM  
CHLORIDE AT DIFFERENT TEMPERATURES.

(Seidell, 1902.)

Results at 10°.			Results at 21.5°.			Results at 27°.		
Gms. per 100 Gms. H <sub>2</sub> O.	Gms. per 100 Gms. H <sub>2</sub> O.		Sp. Gr. of Solutions.	Gms. per 100 Gms. H <sub>2</sub> O.		Sp. Gr. of Solutions.	Gms. per 100 Gms. H <sub>2</sub> O.	
	NaCl.	Na <sub>2</sub> SO <sub>4</sub> .		NaCl.	Na <sub>2</sub> SO <sub>4</sub> .		NaCl.	Na <sub>2</sub> SO <sub>4</sub> .
0.0	0.0	9.14	1.164	0.0	21.33	1.228	0.0	31.10
4.28	6.42		1.169	9.05	15.48	1.230	2.66	28.73
9.60	4.76		1.199	17.48	13.73	1.230	5.29	27.17
15.65	3.99		1.214	20.41	13.62	1.235	7.90	26.02
21.82	3.97		1.243	26.01	15.05	1.259	16.13	24.83
28.13	4.15		1.244	26.53	14.44	1.253	18.91	21.39
30.11	4.34		1.244	27.74	13.39	1.249	19.64	20.11
32.27	4.59		1.244	31.25	10.64	1.245	20.77	19.29
33.76	4.75		1.243	31.80	10.28	1.238	32.33	9.53
			1.245	32.10	8.43			
			1.219	33.69	4.73			
			1.212	34.08	2.77			
			1.197	35.46	0.00			
Results at 30°.			Results at 33°.			Results at 35°.		
Gms. per 100 Gms. H <sub>2</sub> O.	Gms. per 100 Gms. H <sub>2</sub> O.		Sp. Gr. of Solutions.	Gms. per 100 Gms. H <sub>2</sub> O.		Sp. Gr. of Solutions.	Gms. per 100 Gms. H <sub>2</sub> O.	
	NaCl.	Na <sub>2</sub> SO <sub>4</sub> .		NaCl.	Na <sub>2</sub> SO <sub>4</sub> .		NaCl.	Na <sub>2</sub> SO <sub>4</sub> .
0.0	0.0	39.70	1.329	0.0	48.48	1.324	0.0	47.94
2.45	38.25		1.323	1.22	46.49	1.314	2.14	43.75
5.61	36.50		1.318	1.99	45.16	1.256	13.57	26.26
7.91	35.96		1.315	2.64	44.09	1.238	18.78	19.74
10.61	31.64		1.309	3.47	42.61	1.231	31.91	8.28
12.36	29.87		1.265	12.14	29.32	1.193	35.63	0.00
15.65	25.02		1.237	21.87	16.83			
18.44	21.30		1.234	32.84	8.76			
20.66	19.06		1.217	33.99	4.63			
32.43	9.06		1.208	34.77	2.75			



## SOLUBILITY OF SODIUM SULFATE IN AQUEOUS SOLUTIONS OF SODIUM CHLORIDE AT 25°.

(Cameron, Bell and Robinson, 1907.)

$d_m$ of Sat. Sol.	Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.	$d_m$ of Sat. Sol.	Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.
	NaCl.	Na <sub>2</sub> SO <sub>4</sub> .			NaCl.	Na <sub>2</sub> SO <sub>4</sub> .	
1.2173	2.96	26.60	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O	1.2429	26.54	12.64	Na <sub>2</sub> SO <sub>4</sub>
1.2162	5.79	24.32	"	1.2438	31.06	9.98	"
1.2150	9.90	21.41	"	1.2451	32.41	9.93	"
1.2275	13.43	19.62	"	1.2453	33	9.84	" + NaCl
1.2385	15.82	19.64	"	1.2309	33.81	6.66	NaCl
1.2571	19.13	20.73	" + Na <sub>2</sub> SO <sub>4</sub>	1.2162	34.60	3.38	"
1.2476	23.22	16.28	Na <sub>2</sub> SO <sub>4</sub>	1.2002	35.80	0	"

Data are also given for the system sodium sulfate, sodium chloride, calcium sulfate and water at 25°.

## SOLUBILITY OF SODIUM SULFATE IN AQUEOUS SOLUTIONS OF SODIUM HYDROXIDE AT 25°.

(D'Ans and Schreiner, 1910.)

Mols. per 1000 Gms. Sat. Sol.		Solid Phase.	Mols. per 1000 Gms. Sat. Sol.		Solid Phase.
(NaOH) <sub>2</sub> .	Na <sub>2</sub> SO <sub>4</sub> .		(NaOH) <sub>2</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	
0.074	1.41	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O	2.82	0.24	Na <sub>2</sub> SO <sub>4</sub>
0.70	1.08	"	3.52	0.126	"
1.47	0.90	" + Na <sub>2</sub> SO <sub>4</sub>	5.83	0.013	"
2.02	0.59	Na <sub>2</sub> SO <sub>4</sub>	6.62	0	NaOH·H <sub>2</sub> O

## SOLUBILITY OF SODIUM SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 25°.

(D'Ans, 1906; 1909c; 1913.)

Mols. per 1000 Gms. Sat. Sol.		Solid Phase.	Mols. per 1000 Gms. Sat. Sol.		Solid Phase.
H <sub>2</sub> SO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .		SO <sub>3</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	
0	1.541	Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O	8.70	0.076	NaH <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·H <sub>2</sub> O
0.286	1.671	"	8.86	0.156	"
0.338	1.742	"	8.93	0.273	"
0.60	1.85	"	8.84	0.527	" (unstable)
0.763	2	"	8.70	0.808	"
0.884	2.256	" + Na <sub>2</sub> SO <sub>4</sub>	8.62	0.844	"
0.423	0.77	NaHSO <sub>4</sub> ·H <sub>2</sub> O	8.61	0.899	"
0.496	0.47	"	8.87	0.445	" + Na <sub>2</sub> SO <sub>4</sub> ·4H <sub>2</sub> SO <sub>4</sub>
1.666	2.437	Na <sub>2</sub> SO <sub>4</sub> + Na <sub>2</sub> H(SO <sub>4</sub> ) <sub>2</sub>	8.93	0.437	Na <sub>2</sub> SO <sub>4</sub> ·4H <sub>2</sub> SO <sub>4</sub>
1.576	2.363	" + Na <sub>2</sub> H(SO <sub>4</sub> ) <sub>2</sub> ·H <sub>2</sub> O	9.08	0.394	"
2.611	2.091	Na <sub>2</sub> H(SO <sub>4</sub> ) <sub>2</sub> + "	9.36	0.425	" + NaHSO <sub>4</sub>
5.91*	0.409	NaHSO <sub>4</sub>	9.18	0.567	NaHSO <sub>4</sub>
6.30	0.332	"	9.42	0.728	"
6.64	0.297	" + NaH <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·H <sub>2</sub> O	9.48	0.76	"
6.90	0.173	NaH <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·H <sub>2</sub> O	9.48	0.953	" + ?
7.36	0.071	"	9.85	0.787	?
7.74	0.047	"	9.98	0.908	?
8.12	0.037	"	9.77	1.03	unstable
8.40	0.046	"	10.16	0.797	
			10.78	0.302	

\* From this point on the figures in this column are Mols.SO<sub>3</sub> = H<sub>2</sub>SO<sub>4</sub> + SO<sub>3</sub>.

100 cc. sat. solution of Na<sub>2</sub>SO<sub>4</sub> in absolute H<sub>2</sub>SO<sub>4</sub> contain 29.99 gms. Na<sub>2</sub>SO<sub>4</sub> and the molecular compound which is formed contains 8 mols. H<sub>2</sub>SO<sub>4</sub> per 1 mol. Na<sub>2</sub>SO<sub>4</sub> and melts at about 40°.

(Bergius, 1910.)

Aqueous H<sub>2</sub>SO<sub>4</sub> containing 0.51 mol. per liter dissolve 2.238 mols. Na<sub>2</sub>SO<sub>4</sub> per liter at 25°; Aq. H<sub>2</sub>SO<sub>4</sub> of 0.779 mol. per liter dissolves 2.465 mols. Na<sub>2</sub>SO<sub>4</sub> at the same temperature.

(Benz, 1911-12.)



SOLUBILITY OF SODIUM SULFATE IN AQUEOUS ETHYL ALCOHOL.  
(de Bruyn, 1900.)

Concentration of Alcohol in Wt. %	Gms. $\text{Na}_2\text{SO}_4$ per 100 Gms. Aq. Alcohol.	Gms. per 100 Gms. Solution.			Solid Phase.
		$\text{H}_2\text{O}$ .	$\text{C}_2\text{H}_5\text{OH}$ .	$\text{Na}_2\text{SO}_4$ .	
0	12.7	88.7	0	11.3	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
9.2	6.7	85.1	8.6	6.3	"
19.4	2.6	78.6	18.9	2.5	"
39.7	0.5	60	39.5	0.5	"
58.9	0.1	41.1	58.8	0.1	"
72	0	28	72	0	"
0	37.4	72.8	0	27.2	$\text{Na}_2\text{SO}_4 \cdot 7\text{H}_2\text{O}$
11.2	16.3	76.5	9.5	14	"
20.6	7	74.3	19.2	6.5	"
30.2	2	68.4	29.6	2	"
0	28.2	78.1	0	21.9	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
10.6	13.9	78.5	9.3	12.2	"
24	4.5	72.8	22.9	4.3	"
54	0.4	45.6	54	0.4	" + $\text{Na}_2\text{SO}_4$
0	49.3	67	0	33	$\text{Na}_2\text{SO}_4$
8.8	29.2	70.6	6.8	22.6	"
12.8	22.4	71.2	10.5	18.3	"
17.9	15.4	71.1	15.5	13.4	"
18.1	15.3	71	15.7	13.3	"
28.9	5.4	66.5	28.4	5.1	"
48.7	0.8	50.9	48.3	0.8	"
0	47.9	67.6	0	32.4	"
9	27.5	71.3	7.1	21.6	"
14.5	19.2	71.8	12.1	16.1	"
20.6	12.3	70.6	18.4	10	"
31	5.1	65.6	29.5	4.9	"

Following additional determinations at 25° are given by Schreinemakers and Baat (1909):

...	...	63.41	34.84	1.75	$\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
...	...	49	50.5	0.5	"
...	...	46.6	53	0.4	" + $\text{Na}_2\text{SO}_4$
...	...	34.9	64.95	0.15	$\text{Na}_2\text{SO}_4$

At certain concentrations of the aqueous alcohol the liquid separates into two layers. The following results were obtained at 25°, 36° and 45°:

Upper Layer.			Lower Layer.		
Gms. $\text{H}_2\text{O}$ .	Gms. $\text{C}_2\text{H}_5\text{OH}$ .	Gms. $\text{Na}_2\text{SO}_4$ .	Gms. $\text{H}_2\text{O}$ .	Gms. $\text{C}_2\text{H}_5\text{OH}$ .	Gms. $\text{Na}_2\text{SO}_4$ .
66.5	27.3	6.2	67.4	5.1	27.5
68.1	23.9	8.0	68.5	6.0	25.5
68.3	23.1	8.6	68.3	6.7	25.0
...	...	...	66.6	4.1	29.3
57.7	38.4	3.9	...	...	...
65.0	28.3	6.7	68.8	5.9	25.3
68.1	21.2	10.7	68.9	9.4	21.7
61.8	32.9	5.3	...	...	...
65.8	25.3	8.9	68.4	8.8	22.8
66.0	24.0	10.0	68.6	10.1	21.3

for equilibrium in the system  $\text{Na}_2\text{SO}_4 + \text{NaCl} + \text{C}_2\text{H}_5\text{OH} + \text{H}_2\text{O}$  at 15°, 35° are given by Schreinemakers and de Baat (1909), and Schreinemakers



## SODIUM SULFATE

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### SOLUBILITY OF SODIUM SULFATE IN AQUEOUS PROPYL ALCOHOL AT 20°. (Linebarger, 1892.)

Gms. $C_3H_7OH$ per 100 Gms. Alcohol-Water Mixture.	Gms. $Na_2SO_4$ per 100 Gms. Sat. Solution.	Gms. $C_3H_7OH$ per 100 Gms. Alcohol-Water Mixture.	Gms. $Na_2SO_4$ per 100 Gms. Sat. Solution.
42.20	1.99	56.57	0.55
49.77	1.15	60.64	0.44
55.65	0.72	62.81	0.38

100 gms.  $H_2O$  dissolve 183.7 gms. sugar + 30.5 gms.  $Na_2SO_4$  at 31.25°, or 100 gms. sat. solution contain 52.2 gms. sugar + 9.6 gms.  $Na_2SO_4$ . (Köhler, 1891.)  
100 gms. 95% formic acid dissolve 16.5 gms.  $Na_2SO_4$  at 19°. (Aschan, 1913.)

### SOLUBILITY OF SODIUM SULFATE IN AN AQUEOUS SOLUTION OF UREA. (Löwenherz, 1895.)

Solvent.	t°.	Gms. $Na_2SO_4$ per 100 Gms. Sat. Sol.	The Corresponding Fig- ure for the Solubility of $Na_2SO_4$ in Pure Water Was Found to be:
100 gms. $H_2O$ + 12 gms. urea	20.86	22.36	...
" "	24.83	21.21	21.62
" "	28.32	26.50	26.48
" "	29.83	28.23	...
" "	31.90	...	32.34
" "	34.85	27.73	33.09
" "	39.92	27.19	32.58

Fusion-point data for  $Na_2SO_4$  + KCl are given by Sackur (1911-12). Results for  $Na_2SO_4$  +  $SrSO_4$  are given by Calcagni (1912-1912a). Results for  $Na_2SO_4$  +  $Na_2WO_4$  are given by Boeke (1907).

## SODIUM BISULFATE $NaHSO_4$ . (See also last table, p. 670.)

100 gms.  $H_2O$  dissolve 30 gms.  $NaHSO_4$  at 16°. (Aschan, 1913.)  
100 gms.  $H_2O$  dissolve 28.6 gms.  $NaHSO_4$  at 25° and 50 gms. at 100°. (U. S. P. VIII.)  
100 gms. 95 per cent alcohol dissolve about 1.4 gms.  $NaHSO_4$  at 25°. (U. S. P. VIII.)  
100 gms. 95% formic acid dissolve 30 gms.  $NaHSO_4$  at 19.3°. (Aschan, 1913.)

## SODIUM SULFIDE $Na_2S \cdot 9H_2O$ .

### SOLUBILITY IN WATER. (Parravano and Fornaini, 1907.)

t°.	Gms. $Na_2S$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $Na_2S$ per 100 Gms. Sat. Sol.	Solid Phase.
-10 Eutec.	9.34	$Na_2S \cdot 9H_2O$ + Ice	60	29.92	$Na_2S \cdot 5\frac{1}{2}H_2O$
+10	13.36	$Na_2S \cdot 9H_2O$	70	31.38	"
15	14.36	"	80	33.95	"
18	15.30	"	90	37.20	"
22	16.20	"	48 tr. pt.	...	$Na_2S \cdot 9H_2O$ + $Na_2S \cdot 6H_2O$
28	17.73	"	50	26.7	$Na_2S \cdot 6H_2O$
32	19.09	"	60	28.1	"
37	20.98	"	70	30.22	"
45	24.19	"	80	32.95	"
48.9 tr. pt.	...	" + $Na_2S \cdot 5\frac{1}{2}H_2O$	90	36.42	"
50	28.48	$Na_2S \cdot 5\frac{1}{2}H_2O$	91.5 tr. pt.	...	" + $Na_2S \cdot 5\frac{1}{2}H_2O$

Fusion-point data for  $Na_2S$  + S are given by Thomas and Rule (1917).

## SODIUM Antimony SULFIDE. See Sodium Sulfoantimonate, p. 627.



**M SULFITE**  $\text{Na}_2\text{SO}_3$ .

## SOLUBILITY IN WATER.

(Hartley and Barrett, 1909.)

Gms. $\text{Na}_2\text{SO}_3$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Na}_2\text{SO}_3$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
2.15	Ice	18.2	25.31	$\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$
4.21	"	23.5	29.92	" (unstable)
6.24	"	29	34.99	" "
9.44	"	37.2	44.08	" "
12.48	" + $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$	21.6†	...	" + $\text{Na}_2\text{SO}_3$
17.91	Ice (unstable)	37	28.04	$\text{Na}_2\text{SO}_3$
13.09	$\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$	47	28.13	"
14.82	"	55.6	28.21	"
17.61	"	59.8	28.76	"
20.01	"	84	28.26	"

° Eutec.

† tr. pt.

tion was prevented by preparing the material and making the solubility  
ations in an atmosphere of hydrogen.

solubility curves for the salt are also given.

p. Gr. of the sat. solution at 15° is 1.21.

(Greenish and Smith, 1901.)

**M HydroSULFITE**  $\text{Na}_2\text{S}_2\text{O}_4$ .

## SOLUBILITY IN WATER. (Jellinek, 1911.)

Gms. $\text{Na}_2\text{S}_2\text{O}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Na}_2\text{S}_2\text{O}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
0.394	Ice	— 4.58 Eutec.	19	Ice + $\text{Na}_2\text{S}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$
4	"	+ 20	22 ( $\pm 5\%$ error)	$\text{Na}_2\text{S}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$
9	"	52 tr. pt.	27.8	" + $\text{Na}_2\text{S}_2\text{O}_4$
13	"	20	24.1	$\text{Na}_2\text{S}_2\text{O}_4$ (unstable)
17	"			

pure sample was prepared by salting out the commercial product with  
It is very easily oxidized to  $\text{Na}_2\text{S}_2\text{O}_5$  and must be kept in an indifferent  
ere or a vacuum. A special apparatus was required for the freezing-point  
ations (ice curve) and for the solubility determinations. Great difficulty  
erience in obtaining concordant results with a given sample of  $\text{Na}_2\text{S}_2\text{O}_4$ .

**M SULFONATES**

## SOLUBILITY IN WATER.

Salt.	Formula.	t°.	Gms. Anhydrous Salt per 100 Gms. $\text{H}_2\text{O}$ .	Authority.
ndobenzene Sulfonate	$\text{C}_6\text{H}_5\text{I}_2\text{SO}_3\text{Na}$	22.5	6.82	(Boyle, 1909.)
"	$\text{C}_6\text{H}_5\text{I}_2\text{SO}_3\text{Na} \cdot \text{H}_2\text{O}$	22.5	3.47	"
thalene Sulfonate	$\text{C}_{10}\text{H}_7\text{SO}_3\text{Na}$	23.9	6.04	(Fischer, 1906.)
"	"	25	5.87*	(Witt, 1915.)
nathrene Sulfonate	$\text{C}_{14}\text{H}_9\text{SO}_3\text{Na} \cdot \frac{1}{2}\text{H}_2\text{O}$	20	0.42	(Sandquist, 1912.)
"	$\text{C}_{14}\text{H}_9\text{SO}_3\text{Na} \cdot \text{H}_2\text{O}$	20	1.1	"
"	$\text{C}_{14}\text{H}_9\text{SO}_3\text{Na} \cdot 2\text{H}_2\text{O}$	20	1.63	"
Sulfonate	$\text{C}_6\text{H}_4(\text{OH})\text{SO}_3\text{Na} \cdot 2\text{H}_2\text{O}$	15	14.7†	(Greenish & Smith, '01.)
"	"	25	19.2‡	(Seidell, 1910.)

\*  $d_{20} = 1.079$ .†  $d_{20} = 1.067$ .‡  $d_{20} = 1.079$ 

SOLUBILITY OF SODIUM  $\beta$  NAPHTHALENE SULFONATE IN AQUEOUS HYDRO-  
CHLORIC ACID AT 23.9°. (Fischer 1906.)

Normality of Aq. HCl.	1.0 N.	2 N.	3 N.	5 N.
$\text{C}_{10}\text{H}_7\text{SO}_3\text{Na}$ per 100 gms. Aq. HCl	6.47	5.35	4.13	2.42



## SODIUM SULFONATES

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### SOLUBILITY OF SODIUM PHENOL SULFONATE IN AQUEOUS ALCOHOL AT 25°. (Seidell, 1910.)

Wt. Per cent $C_6H_5OH$ in Solvent.	$d_m$ of Sat. Sol.	Gms. $C_6H_5(OH)-$ $SO_3Na \cdot 2H_2O$ per 100 Gms. Sat. Sol.	Wt. Per cent $C_6H_5OH$ in Solvent.	$d_m$ of Sat. Sol.	Gms. $C_6H_5(OH)-$ $SO_3Na \cdot 2H_2O$ per 100 Gms. Sat. Sol.
0 (= $H_2O$ )	1.079	19.38	60	0.919	7.5
10	1.054	17.4	70	0.886	5.1
20	1.030	15.5	80	0.852	2.9
30	1.004	13.6	90	0.820	1.1
40	0.977	11.7	95	0.810	0.8
50	0.950	9.7	100	0.800	1.5

In the 100 per cent  $C_6H_5OH$  solution, the solid phase,  $C_6H_4(OH)SO_3Na \cdot 2H_2O$ , became opaque.

100 gms.  $H_2O$  dissolve 18.25 gms.  $C_6H_4(OH)SO_3Na \cdot 2H_2O$  at 14.8°,  $d_{444}$  of sat. sol. = 1.0675.  
(Greenish and Smith, 1901.)

## SODIUM TARTRATES

### SOLUBILITY IN WATER.

Salt.	Formula.	t°.	Gms. Salt per 100 Gms. $H_2O$ .	Authority.
Sodium Neutral Inactive Pyrotartrate	$C_6H_6O_6 \cdot Na_2 \cdot 6H_2O$	20	39.73	(Schlomburg, 1901.)
" Dextro "	" "	20	41.10	"
Sodium Dihydroxy Tartrate	$C_4H_4O_6 \cdot Na_2 \cdot 3H_2O$	0	0.039	(Fenton, 1894.)

## SODIUM TELLURATE $Na_2TeO_4 \cdot 2H_2O$ .

100 gms.  $H_2O$  dissolve 0.77 gm.  $Na_2TeO_4$  at 18°, and 2 gms. at 100°. Solid phase  $Na_2TeO_4 \cdot 2H_2O$ .

100 gms.  $H_2O$  dissolve 1.43 gms.  $Na_2TeO_4$  at 18°, and 2.5 gms. at 50°. Solid phase  $Na_2TeO_4 \cdot 4H_2O$ .  
(Mylum, 1901.)

## SODIUM THIOSULFATE $Na_2S_2O_3 \cdot 5H_2O(I)$ .

### SOLUBILITY IN WATER. (Young and Burke, 1904, 1906.)

t°.	Gms. $Na_2S_2O_3$ per 100 Gms.		Solid Phase.	t°.	Gms. $Na_2S_2O_3$ per 100 Gms.		Solid Phase.
	Sat. Sol.	Water.			Sat. Sol.	Water.	
0	33.40	50.15	$Na_2S_2O_3 \cdot 5H_2O(I)$	0	60.47	153	$Na_2S_2O_3 \cdot H_2O(II)$
10	37.37	59.66	"	10	61.04	156.7	"
20	41.20	70.07	"	20	62.11	163.9	"
25	43.15	75.90	"	25	62.73	168.3	"
35	47.71	91.24	"	30	63.56	174.4	"
45	55.33	123.87	"	40	65.22	187.6	"
48.17*	...	...	" + $Na_2S_2O_3 \cdot 2H_2O(II)$	50	66.82	201.4	"
0	52.73	111.60	$Na_2S_2O_3 \cdot 2H_2O(II)$	56.5*	...	...	" + $Na_2S_2O_3$
10	53.94	117.10	"	0	46.14	85.67	$Na_2S_2O_3 \cdot 6H_2O(III \text{ and } IV)$
20	55.15	122.68	"	10	51.66	106.8	"
25	56.03	127.43	"	13	54.96	122	"
30	57.13	138.84	"	14.35*	...	...	" + $Na_2S_2O_3 \cdot 4H_2O(IV)$
40	59.38	146.20	"	14.3*	...	...	" + $Na_2S_2O_3 \cdot 7H_2O(III)$
50	62.28	165.11	"	0	57.42	134.8	$Na_2S_2O_3 \cdot 7H_2O(III)$
60	65.68	191.30	"	10	58.28	139.7	"
66.5*	...	...	" + $Na_2S_2O_3$	20	59.28	145.6	"
0	41.96	72.30	$Na_2S_2O_3 \cdot 5H_2O(II)$	25	60.18	151.1	"
10	45.25	82.65	"	30	60.78	155	"
20	49.38	97.55	"	40	62.60	167.4	"
25	52.15	108.98	"	47.5	64.68	183.1	"
30	56.57	130.26	"	48.5*	...	...	" + $Na_2S_2O_3 \cdot H_2O(III)$
30.22*	...	...	" + $Na_2S_2O_3 \cdot 4H_2O(II)$	47.5	64.78	183.9	$Na_2S_2O_3 \cdot H_2O(III)$
33.5	58.59	141.48	$Na_2S_2O_3 \cdot 4H_2O(II)$	50	65.3	188.2	"
36.2	60.51	153.23	"	55	66.45	198.1	"
36.6	62.80	168.82	"	60	68.07	213.1	"
40.65*	...	..	" + $Na_2S_2O_3 \cdot H_2O(II)$	61*	...	...	" + $Na_2S_2O_3$

\* tr. pt.



## SOLUBILITY IN WATER (Continued).

Gms. $\text{Na}_2\text{S}_2\text{O}_3$ per 100 Gms.			Solid Phase.	t°.	Gms. $\text{Na}_2\text{S}_2\text{O}_3$ per 100 Gms.			Solid Phase.
Sat. Sol.	Water.				Sat. Sol.	Water.		
57.63	136		$\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ (IV)	30	63.34	172.80		$\text{Na}_2\text{S}_2\text{O}_3 \cdot \text{H}_2\text{O}$ (V)
58.49	140.9		"	40	64.75	183.70		"
59.57	147.3		"	50	66.58	199.2		"
60.35	152.2		"	55	67.59	208.5		"
61.03	156.6		"	43*	...	...		" + $\text{Na}_2\text{S}_2\text{O}_3 \cdot 1\text{H}_2\text{O}$ (V)
62.95	169.9		"	25	64.21	179.4		$\text{Na}_2\text{S}_2\text{O}_3 \cdot 1\text{H}_2\text{O}$ (V)
65.45	189.5		"	40	64.99	185.6		"
67.07	203.7		"	50	66.02	194.3		"
...	...		" + $\text{Na}_2\text{S}_2\text{O}_3$	60	67.4	206.7		"
57.63	136		$\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ (V)	70	69.06	223.2		"
59.05	144.2		"	70*	...	...		" + $\text{Na}_2\text{S}_2\text{O}_3$
61.02	156.5		"	40	67.4	206.7		$\text{Na}_2\text{S}_2\text{O}_3$
62.30	165.3		"	50	67.76	210.2		"
63.56	174.4		"	60	68.48	217.3		"
65.27	188		"	70	69.05	223.1		"
5*	...		" + $\text{Na}_2\text{S}_2\text{O}_3 \cdot \text{H}_2\text{O}$ (V)	80	69.86	231.8		"

\* tr. pt.

The authors adopted a new system of naming the hydrates, based upon their solubility transition relations. These transitions occur in such a way that the members of one group undergo transition into members of the same group and into members of another group. Those hydrates belonging to group (I) are primary hydrates, those belonging to group (II) are called secondary and those belonging to the (III), (IV) and (V) groups are called tertiary, quaternary and quintary respectively.

Commercial sodium thiosulfate is the primary pentahydrate,  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$  (I).

10 gms. alcohol dissolve 0.0025 gm.  $\text{Na}_2\text{S}_2\text{O}_3$  and 0.0034 gm.  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$  at 15.5° temperature. (Böttcher, 1897.)

10 gms. alcohol of 0.941 Sp. Gr. dissolve 33.3 gms. sodium thiosulfate at 15.5°.

Data for the lowering of the freezing-point of  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$  by each of the following compounds: urea, glucose, cane sugar, NaCl,  $\text{NaClO}_3$ ,  $\text{NaNO}_3$  and  $\text{Na}_2\text{SO}_4$  are given by Bautaric (1911).

SODIUM TUNGSTATE  $\text{Na}_2\text{WO}_4 \cdot 2\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Funk, 1900a.)

Gms. $\text{Na}_2\text{WO}_4$ per 100 Gms. Solution.	Mols. $\text{Na}_2\text{WO}_4$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Na}_2\text{WO}_4$ per 100 Gms. Solution.	Mols. $\text{Na}_2\text{WO}_4$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
30.60	2.70	$\text{Na}_2\text{WO}_4 \cdot 10\text{H}_2\text{O}$	-3.5	41.67	4.37	$\text{Na}_2\text{WO}_4 \cdot 5\text{H}_2\text{O}$
31.87	2.86	"	+0.5	41.73	4.39	"
32.98	3.01	"	18	42.0	4.40	"
34.52	3.23	"	21	42.27	4.48	"
36.54	3.52	"	43.5	43.98	4.81	"
39.20	3.95	"	80.5	47.65	5.57	"
41.02	4.26	"	100	49.31	5.95	"

Sp. Gr. of sat. solution at 18° = 1.573. For Sp. Gr. determinations of aqueous solutions at 20°, see Pawlewski, 1900.

Freezing-point data for  $\text{Na}_2\text{WO}_4 + \text{WO}_3$  are given by Parravano (1909).



**SODIUM URATE**

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**SODIUM URATE**  $C_5H_3N_4O_7 \cdot Na$ .**SOLUBILITY IN AQUEOUS SODIUM CHLORIDE AT 37°.**

(d'Agostino, 1910.)

Gms. Mols. per Liter.		Gms. Mols. per Liter.		Gms. Mols. per Liter.	
NaCl.	$C_5H_3N_4O_7 \cdot Na$ .	NaCl.	$C_5H_3N_4O_7 \cdot Na$ .	NaCl.	$C_5H_3N_4O_7 \cdot Na$ .
0	0.00536	0.01084	0.00211	0.05116	0.00050
0.00486	0.00340	0.01398	0.00172	0.06667	0.00034
0.00532	0.00321	0.02564	0.00102	0.07363	0.00032
0.00865	0.00256	0.04012	0.00054	0.08595	0.00026

One liter of  $H_2O$  dissolves 1.5 gms. sodium urate at 37°. (Bechhold and Ziegler, 1910.)

One liter of serum dissolves 0.025 gm. sodium urate at 37°.

**SODIUM MetaVANADATE**  $NaVO_3$ .**SOLUBILITY IN WATER.**

(MacAdam and Pierle, 1912.)

t°.	Gms. $NaVO_3$ per 100 Gms. $H_2O$ .	Solid Phase.	t°.	Gms. $NaVO_3$ per 100 Gms. $H_2O$ .	Solid Phase.
25	21.10	$NaVO_3$	25	15.3	$NaVO_3 \cdot H_2O$
40	26.23	"	40	30.2	"
60	32.97	"	60	68.4	"
75	38.83	"	75	38.8	$NaVO_3$

Considerable time was required for attainment of equilibrium. The two solid phases appear to exist for the whole range of temperature and the conditions for the transformation of one into the other were not ascertained.

**SODIUM FluozIRCONATE**  $5NaF \cdot ZrF_6$ .100 gms.  $H_2O$  dissolve 0.387 gm. at 18°, and 1.67 gms. at 100°. (Marignac, 1861.)**SPARTEINE**  $C_{15}H_{25}N_3$ .**SOLUBILITY IN WATER AND IN AQUEOUS SODIUM CARBONATE SOLUTIONS.**

(Valeur, 1917.)

The author prepared solutions of recently distilled colorless sparteine ( $\alpha = -2^\circ.46'$  in 5 cm. tube) in aqueous 5 per cent  $Na_2CO_3$  and determined the temperature at which clouding occurred in each.

t° of Clouding.	Gms. $C_{15}H_{25}N_3$ per 100 cc.	t° of Clouding.	Gms. $C_{15}H_{25}N_3$ per 100 cc.	t° of Clouding.	Gms. $C_{15}H_{25}N_3$ per 100 cc.
23.4	2.1	33.5	1.5	47	0.9
24	1.95	36.5	1.35	53	0.75
25	1.8	39.8	1.2	60.2	0.60
28.6	1.65	43.5	1.05	72.5	0.45

A saturated solution of sparteine in water was prepared, and after removing the solid phase by centrifugation, the amount of sparteine in the saturated solution was determined with the aid of the data in the above table. Enough  $Na_2CO_3$  and  $H_2O$  to yield 5 per cent  $Na_2CO_3$  were added and the temperature of clouding observed and compared with the above results. The average of these determinations was 0.556 gm. sparteine per 100 cc. sat. solution in water at 10.8°.

**SPARTEINE SULFATE**  $C_{15}H_{25}N_3 \cdot H_2SO_4 \cdot 5H_2O$ .100 gms.  $H_2O$  dissolve about 200 gms. sparteine sulfate at 15–20°.

100 cc. 90% alcohol dissolve about 20 gms. sparteine sulfate at 15–20°.

(Squire and Caines, 1905.)

**STEARIC ACID**  $CH_3(CH_2)_{16}COOH$ .100 gms.  $H_2O$  dissolve 0.1 gm. stearic acid at 37°.

100 gms. 5% aqueous solution of bile salts dissolve less than 0.1 gm. stearic acid.

100 gms. 5% aq. sol. of bile salt + 1% lecithin dissolve 0.2 gm. stearic acid.

In the same solvents there is dissolved of sodium stearate, 0.1, 0.2 and 0.7 gm. respectively. (Moore, Wilson and Hutchinson, 1909.)



## SOLUBILITY OF STEARIC ACID IN AQUEOUS ETHYL ALCOHOL AT 25°.

(Seidell, 1910.)

t. % H <sub>2</sub> O in solvent.	$d_{25}$ of Sat. Sol.	Gms. C <sub>17</sub> H <sub>35</sub> COOH per 100 Gms. Sat. Sol.	Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	$d_{25}$ of Sat. Sol.	Gms. C <sub>17</sub> H <sub>35</sub> COOH per 100 Gms. Sat. Sol.
0	0.999	0.034	70	0.865	0.80
20	0.967	0.04	80	0.841	1.63
40	0.932	0.10	90	0.818	3.30
50	0.911	0.18	95	0.807	5.55
60	0.888	0.40	100	0.795	8.30

10 cc. { 94.3 Vol. % C<sub>2</sub>H<sub>5</sub>OH contain 0.0996 gm. C<sub>17</sub>H<sub>35</sub>COOH at 0° ( $d_0 = 0.8318$ ).  
 t. sol. { 95.1 " " " 0.1139 " " ( $d_0 = 0.8287$ ).  
 in { 95.7 " " " 0.1246 " " ( $d_0 = 0.8265$ ).

turation was approached from above without constant agitation. (Emerson, 1907.)

## SOLUBILITY OF STEARIC ACID IN ETHYL ALCOHOL AT SEVERAL TEMPERATURES.

(Falcia, 1910.)

t°.	Gms. C <sub>17</sub> H <sub>35</sub> COOH per 100 cc. of:		
	Absolute Alcohol.	75% Alcohol.	50% Alcohol.
10	0.9	0.15	...
20	2	...	0.08 (23°)
30	4.5	0.39	0.10
40	13.8	0.77	0.12

10 cc. sat. solution in 94.4 Vol. % CH<sub>3</sub>OH ("methylated alcohol" of  $d = 0.813$ ) contain 0.15 gm. C<sub>17</sub>H<sub>35</sub>COOH at +0.2°. Saturation was approached above without constant agitation. (Hehner and Mitchell, 1897.)

## SOLUBILITY OF STEARIC ACID IN SEVERAL SOLVENTS AT 25°.

(Seidell, 1910.)

Solvent.	$d$ of Solvent.	$d_{25}$ of Sat. Sol.	Gms. C <sub>17</sub> H <sub>35</sub> COOH per 100 Gms. Sat. Sol.
Acetone	$d_{15} = 0.797$	0.815	4.73
Amyl Alcohol (iso)	$d_{20} = 0.817$	0.815	9.43
Amyl Acetate	$d_{20} = 0.875$	0.867	11.19
Carbon Disulfide	$d_{25} = 1.259$	1.163	19.20
Carbon Tetrachloride	$d_{25} = 1.587$	1.465	10.25
Chloroform	$d_{22} = 1.476$	1.332	15.54
Ether (abs.)	$d_{22} = 0.711$	0.744	20.04
Ethyl Acetate	$d_{25} = 0.892$	0.895	7.36
Nitrobenzene	$d_{25} = 1.205$	1.199	1.24
Toluene	$d_{15} = 0.872$	0.865	13.61

melting-point data for stearic acid + tristearin and for stearic acid + tri-  
 n + palmitic acid are given by Kremann and Kropsch (1914).

STILBENE C<sub>6</sub>H<sub>5</sub>CH:CH.C<sub>6</sub>H<sub>5</sub>.

melting-point data for mixtures of stilbene and *p* dimethoxystilbene are given  
 by Falcia and Normand (1913).

STRONTIUM ACETATE Sr(CH<sub>3</sub>COO)<sub>2</sub>·½H<sub>2</sub>O.

## SOLUBILITY IN WATER.

(Osaka and Abe, 1911.)

t°.	Gms. Sr(CH <sub>3</sub> COO) <sub>2</sub> per 100 Gms. H <sub>2</sub> O.	Solid Phase.	t°.	Gms. Sr(CH <sub>3</sub> COO) <sub>2</sub> per 100 Gms. H <sub>2</sub> O.	Solid Phase.
05	36.93	Sr(CH <sub>3</sub> COO) <sub>2</sub> ·4H <sub>2</sub> O	25	40.19	Sr(CH <sub>3</sub> COO) <sub>2</sub> ·½H <sub>2</sub> O
	39.91	"	35.03	38.82	"
	43.61	"	50	37.35	"
4 tr. pt.	43.1	" + Sr(CH <sub>3</sub> COO) <sub>2</sub> ·½H <sub>2</sub> O	70	36.24	"
	43.5	Sr(CH <sub>3</sub> COO) <sub>2</sub> ·½H <sub>2</sub> O	80	36.10	"
	42.95	"	90	36.24	"
	41.90	"	97	36.36	"



**STRONTIUM BENZOATE** 678**STRONTIUM BENZOATE**  $\text{Sr}(\text{C}_7\text{H}_5\text{O}_2)_2 \cdot \text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Pajetta, 1906.)

$t^\circ$ .	$15.7^\circ$ .	$24.7^\circ$ .	$31.4^\circ$ .	$40.9^\circ$ .
Gms. $\text{Sr}(\text{C}_7\text{H}_5\text{O}_2)_2$ per 100 Gms. Solution	5.31	5.4	5.56	5.77

**STRONTIUM BROMATE**  $\text{Sr}(\text{BrO}_3)_2$ .

One liter of aqueous solution contains 0.9 gm. molecules or 309 gms.  $\text{Sr}(\text{BrO}_3)_2$  at  $18^\circ$ .  
(Kohlrausch, 1897.)

**STRONTIUM BROMIDE**  $\text{SrBr}_2 \cdot 6\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Average curve from results of Kremers, 1858; and Etard, 1894.)

$t^\circ$ .	Gms. $\text{SrBr}_2$ per 100 Gms.		$t^\circ$ .	Gms. $\text{SrBr}_2$ per 100 Gms.	
	Solution.	Water.		Solution.	Water.
0	46	85.2	40	55.2	123.2
10	48.3	93	50	57.6	135.8
20	50.6	102.4	60	60	150
25	51.7	107	80	64.5	181.8
30	52.8	111.9	100	69	222.5

Sp. Gr. of sat. solution at  $20^\circ$  approximately 1.70.100 gms. abs. alcohol dissolve 64.5 gms.  $\text{SrBr}_2$  at  $0^\circ$ .Sp. Gr. of solution = 1.21.  
(Fonnes-Diacon, 1895.)SOLUBILITY OF STRONTIUM BROMIDE IN AQUEOUS SOLUTIONS OF STRONTIUM NITRATE AT  $25^\circ$ .

(Harkins and Pearce, 1916.)

Mols. per 1000 Gms. $\text{H}_2\text{O}$ .	Gms. $\text{SrBr}_2$ per 1000 Gms. $\text{H}_2\text{O}$ .	$d_{25}^4$ of Sat. Sol.	Mols. per 1000 Gms. $\text{H}_2\text{O}$ .	Gms. $\text{SrBr}_2$ per 1000 Gms. $\text{H}_2\text{O}$ .	$d_{25}^4$ of Sat. Sol.
$\text{Sr}(\text{NO}_3)_2$ .	$\text{SrBr}_2$ .		$\text{Sr}(\text{NO}_3)_2$ .	$\text{SrBr}_2$ .	
0	4.3080	1066.1	0.30663	4.3180	1068.8
0.036	4.3105	1066.95	0.61124	4.3190	1069.17
0.07216	4.3125	1067.42	1.8610	4.3390	1073.97
0.14568	4.3170	1068.54			

Data for equilibrium in the system strontium bromide, strontium oxide and water at  $25^\circ$  are given by Milikau (1916).

**STRONTIUM CAMPHORATE**  $d \text{ C}_{10}\text{H}_{16}\text{O}_4\text{Sr} \cdot 4\text{H}_2\text{O}$ .SOLUBILITY IN AQUEOUS SOLUTIONS OF CAMPHORIC ACID AT  $16-17^\circ$ .

(Jungfleisch and Landrieu, 1914.)

Gms. per 100 Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	Solid Phase.
$\text{C}_8\text{H}_{16}(\text{COOH})_2$ .		$\text{C}_8\text{H}_{16}(\text{COOH})_2$ .	
1.25	$\text{C}_{10}\text{H}_{16}\text{O}_4\text{Sr}$ .	1.20	$\text{C}_{10}\text{H}_{16}\text{O}_4\text{Sr}$ .
1.03	$\text{C}_8\text{H}_{16}(\text{COOH})_2$	17.99	$(\text{C}_{10}\text{H}_{16}\text{O}_4)_2\text{Sr}(\text{C}_{10}\text{H}_{16}\text{O}_4)_2$
1.13	$(\text{C}_{10}\text{H}_{16}\text{O}_4)_2\text{Sr}(\text{C}_{10}\text{H}_{16}\text{O}_4)_2$	16.95	$\text{C}_{10}\text{H}_{16}\text{O}_4\text{Sr} \cdot 4\text{H}_2\text{O}$
1.20	"	16.56	"
		12.86 (at $98^\circ$ )	"

**STRONTIUM CARBONATE**  $\text{SrCO}_3$ .

One liter of water dissolves 0.00082 gm. at  $8.8^\circ$  and 0.0109 gm. at  $24^\circ$  by conductivity method.  
(Holleman, 1893; Kohlrausch and Rose, 1893.)

One liter of water saturated with  $\text{CO}_2$  dissolves 1.19 gms.  $\text{Sr}(\text{HCO}_3)_2$ .

Data for the solubility of strontium carbonate in water containing  $\text{CO}_2$  at pressures between 0.05 and 1.1 atmospheres are given by McCoy and Smith (1911). The equilibrium constant is  $k = 1.29 \times 10^{-2}$  with an average deviation from the mean of 1.2 per cent. From this value, the solubility product is calculated to be  $\text{Sr} \times \text{CO}_3 = k_2 = 1.567 \times 10^{-2}$ .



## SOLUBILITY OF STRONTIUM CARBONATE IN AQUEOUS AMMONIUM CHLORIDE.

(Cantoni and Goguelis, 1905.)

Gms. $\text{NH}_4\text{Cl}$ per 100 Gms. Solution.	Gms. $\text{SrCO}_3$ per 1000 cc. Sat. Solution.
5.35	0.179
10	0.259
20	0.358

mixtures were allowed to stand at 12–18° for 98 days.

n-point data for  $\text{SrCO}_3 + \text{SrCl}_2$  are given by Sackur (1911–12).STRONTIUM CHLORATE  $\text{Sr}(\text{ClO}_3)_2$ .ms.  $\text{H}_2\text{O}$  dissolve 174.9 gms.  $\text{Sr}(\text{ClO}_3)_2$ , or 100 gms. sat. solution contain s. at 18°. Sp. Gr. of solution is 1.839.

(Mylus and Funk, 1897.)

STRONTIUM CHLORIDE  $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER.

(Average curve from the results of Mulder; Etard; see also Tilden, 1884.)

Gms. $\text{SrCl}_2$ per 100 Gms. Solution.		Solid Phase.	t°.	Gms. $\text{SrCl}_2$ per 100 Gms. Solution.		Solid Phase.
Solution.	Water.			Solution.	Water.	
26.0	35.1	$\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$	60	45.0	81.8	$\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$
30.3	43.5	"	70	46.2	85.9	$\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$
32.3	47.7	"	80	47.5	90.5	"
34.6	52.9	"	100	50.2	100.8	"
35.8	55.8	"	120	53.0	112.8	"
37.0	58.7	"	140	55.6	125.2	"
39.5	65.3	"	160	58.5	141.0	"
42.0	72.4	"	180	62.0	163.1	"

ation temperature about 62.5°. Sp. Gr. of sat. solution at 0° = 1.334; at .36.

## SOLUBILITY OF STRONTIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AT 0°. (Engel, 1888.)

Mg. Mols. per 10 cc. Solution. $\frac{1}{2}\text{SrCl}_2$		Sp. Gr. of Solution.	Grams per 100 cc. Solution. $\text{SrCl}_2$	
$\frac{1}{2}\text{SrCl}_2$	HCl.		$\text{SrCl}_2$	HCl.
51.6	0	1.334	40.9	0.0
44.8	6.1	1.304	35.5	2.22
37.85	12.75	1.269	30.0	4.65
27.2	23.3	1.220	21.56	8.49
22.0	28.38	1.201	17.44	10.35
14.0	37.25	1.167	11.09	13.58
4.25	52.75	1.133	3.37	19.23

## SOLUBILITY OF STRONTIUM CHLORIDE IN AQUEOUS SOLUTIONS OF HYDROBROMIC AND OF HYDROCHLORIC ACIDS AT 25°. (Harkins and Paine, 1916.)

In Aqueous HBr.			In Aqueous HCl.		
div. HBr Gms.	$d_{25}^4$ of Sat. Sol.	Gms. $\text{SrCl}_2$ per 100 Gms. Sat. Sol.	Gms. Equiv. HCl per 1000 Gms. $\text{H}_2\text{O}$ .	$d_{25}^4$ of Sat. Sol.	Gms. $\text{SrCl}_2$ per 100 Gms. Sat. Sol.
	1.4015	35.80	0.1551	1.3953	35.17
817	1.4020	35.47	0.5162	1.3788	33.60
91	1.4010	33.92	1.017	1.3563	31.42
16	1.3992	31.52	2.165	1.3065	26.33
4	1.3995	20.78	9.205	1.1498	3.055



## STRONTIUM CHLORIDE

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### SOLUBILITY OF STRONTIUM CHLORIDE IN AQUEOUS SOLUTIONS OF ACIDS AND OF SALTS AT 25°. (Harkins and Paine, 1916.)

Aqueous Solution of:	Gms. Equiv. added Salt per 1000 Gms. H <sub>2</sub> O.	$d_{25}^0$ of Sat. Sol.	Gms. SrCl <sub>2</sub> per 100 Gms. Sat. Sol.	Aqueous Solution of:	Gms. Equiv. added Salt per 1000 Gms. H <sub>2</sub> O.	$d_{25}^0$ of Sat. Sol.	Gms. SrCl <sub>2</sub> per 100 Gms. Sat. Sol.
CuCl <sub>2</sub>	0.7134	1.4200	34.005	KNO <sub>3</sub>	0.09796	1.4107	35.86
"	2.276	1.4595	30.40	"	0.4755	1.4349	35.90
HI	0.1641	1.4058	34.850	HNO <sub>3</sub>	0.1771	1.4038	35.52
"	0.4462	1.4121	33.28	"	0.3521	1.4059	35.40
"	0.7539	1.4196	31.52	"	1.277	1.4175	34.04
KI	0.09199	1.4093	35.45	NaNO <sub>3</sub>	0.3621	1.4216	35.63
"	0.5401	1.4466	33.79	"	0.5010	1.4588	35.60
"	0.6015	1.4513	33.60	"	3.553	1.5214	30.88
"	1.445	1.5154	30.90	"	6.856	1.5581	25.53
KCl	0.0719	1.4032	35.62	Sr(NO <sub>3</sub> ) <sub>2</sub>	0.1372	1.4113	35.42
"	0.433	1.4085	34.80	"	0.5766	1.4336	34.47
"	0.8576	1.4152	33.89	"	1.0988	1.4636	33.30
"	1.594	1.4266	32.40	"	3.318	1.6664	28.97

Data for equilibrium in the system strontium chloride, strontium oxide and water at 0°, 25° and 40° are given by Milikau (1916).

100 gms. abs. methyl alcohol dissolve 63.3 gms. SrCl<sub>2</sub>.6H<sub>2</sub>O at 6°.

100 gms. abs. ethyl alcohol dissolve 3.8 gms. SrCl<sub>2</sub>.6H<sub>2</sub>O at 6°. (de Bruyn, 1892.)

### SOLUBILITY OF STRONTIUM CHLORIDE IN AQUEOUS ETHYL ALCOHOL SOLUTIONS AT 18°. (Gerardin, 1865.)

Sp. Gr. of Aq. Alcohol at 0°.	Wt. per cent Alcohol.	Gms. SrCl <sub>2</sub> per 100 Gms. Alcohol.	Sp. Gr. of Aq. Alcohol at 0°.	Wt. per cent Alcohol.	Gms. SrCl <sub>2</sub> per 100 Gms. Alcohol.
0.990	6	49.81	0.939	45	26.8
0.985	10	47.0	0.909	59	19.2
0.973	23	39.6	0.846	86	4.9
0.966	30	35.9	0.832	91	3.2
0.953	38	30.4			

100 gms. 95% formic acid dissolve 23.8 gms. SrCl<sub>2</sub> at 19°.

(Aschan, 1913)

100 cc. anhydrous hydrazine dissolve 8 gms. SrCl<sub>2</sub> at room temp.

(Welsh and Broderson, 1915)

Fusion-point data for SrCl<sub>2</sub> + SrF<sub>2</sub> are given by Plato (1907). Results for SrCl<sub>2</sub> + SrO and SrCl<sub>2</sub> + SrSO<sub>4</sub> by Sackur (1911-12). Results for SrCl<sub>2</sub> + TiCl<sub>4</sub> by Korreng (1914) and results for SrCl<sub>2</sub> + ZnCl<sub>2</sub> by Sandonnini (1912a, 1914)

## STRONTIUM CHROMATE SrCrO<sub>4</sub>.

### SOLUBILITY IN WATER, ETC., AT 15°. (Fresenius, 1891.)

Solvent.	Gms. SrCrO <sub>4</sub> per 100 Gms. Solvent.	Solvent.	Gms. SrCrO <sub>4</sub> per 100 Gms. Solvent.
Water	0.12	Aq. Ethyl Alcohol (29%)	0.0132
Aq. NH <sub>4</sub> Cl (5%)	0.195	Aq. Ethyl Alcohol (53%)	0.002
Aq. CH <sub>3</sub> COOH (1%)	1.57		



**STRONTIUM CINNAMATE**  $(C_6H_5CH:CH.CO_2)_2Sr \cdot 2H_2O$ .gms.  $H_2O$  dissolve 1 gm.  $(C_6H_5CH:CH.CO_2)_2Sr$  at  $15^\circ-20^\circ$ .gms. sat. aqueous solution contain 1.18 gm.  $(C_6H_5CH:CH.CO_2)_2Sr$  at  $15^\circ$  (Squire and Caines, 1905.)  
11 gms. at  $100^\circ$ . (Tarugi and Checchi, 1901.)**STRONTIUM FORMATE**  $Sr(HCOO)_2 \cdot 2H_2O$ .

## SOLUBILITY IN WATER. (Stanley, 1904.)

Gms. $Sr(HCOO)_2$ per 100 Gms. $H_2O$ .	Solid Phase.	t°.	Gms. $Sr(HCOO)_2$ per 100 Gms. $H_2O$ .	Solid Phase.
7.02 (8.35)	$Sr(HCOO)_2 \cdot 2H_2O$	67.5	20.62 (21.76)	$Sr(HCOO)_2 \cdot 2H_2O$
8.08 (9.54)	"	81.5	26.14 (26.36)	"
11.62 (13.25)	"	86	27.58 (27.57)	$Sr(HCOO)_2 \cdot H_2O$
13.01 (14.68)	"	91.7	27.01 (27.07)	"
16.31 (17.83)	"	100	26.57 (26.72)	"

It appears to be an error in the calculation of the results as given by the author in his table. The figures given above in parentheses have, therefore, been calculated from the weights of  $SrSO_4$  recorded in the original table and the weight of  $Sr(HCOO)_2$  per 100 gms. of saturated solution.

**STRONTIUM FLUORIDE**  $SrF_2$ .

liter of water dissolves 0.1135 gm.  $SrF_2$  at  $0.26^\circ$ , 0.1173 gm. at  $17.4^\circ$  and 0.1173 gm. at  $27.4^\circ$ , determined by the conductivity method. (Kohlrausch, 1908.)

**STRONTIUM GLYCEROPHOSPHATE**  $C_3H_7O_3PO_4 \cdot Sr \cdot 2H_2O$ .

gms. sat. solution in water contain 2.09 gms. anhydrous salt at  $18^\circ$  and 0.8 gm. at  $60^\circ$ . (Rogier and Fiore, 1911.)

**STRONTIUM HYDROXIDE**  $Sr(OH)_2 \cdot 8H_2O$ .

## SOLUBILITY IN WATER. (Scheibler, 1883.)

t°.	Grams per 100 Grams Solution.		Grams per 100 cc. Solution.	
	SrO.	$Sr(OH)_2 \cdot 8H_2O$ .	SrO.	$Sr(OH)_2 \cdot 8H_2O$ .
0	0.35	0.90	0.35	0.90
10	0.48	1.23	0.48	1.23
20	0.68	1.74	0.68	1.74
30	1.00	2.57	1.01	2.59
40	1.48	3.80	1.51	3.87
50	2.13	5.46	2.18	5.59
60	3.03	7.77	3.12	8.00
70	4.35	11.16	4.55	11.67
80	6.56	16.83	7.02	18.01
90	12.0	30.78	13.64	34.99
100	18.6	47.71	22.85	58.61

RELATIVE SOLUBILITY OF STRONTIUM HYDROXIDE AND STRONTIUM NITRATE IN WATER AT  $25^\circ$ . (Parsons and Perkins, 1910.)

L	Gms. per 100 Gms. $H_2O$ .		Solid Phase.	$d_{25}^{20}$ of Sat. Sol.	Gms. per 100 Gms. $H_2O$ .		Solid Phase.
	SrO as $Sr(OH)_2$ .	$Sr(NO_3)_2$ .			SrO as $Sr(OH)_2$ .	$Sr(NO_3)_2$ .	
	0	79.27	$Sr(NO_3)_2$	1.267	1.11	37.81	$Sr(OH)_2 \cdot 8H_2O$
	0.38	79.47	"	1.217	1.01	28.80	"
	0.78	80.83	"	1.178	0.95	23.83	"
	1.76	81.06	$Sr(OH)_2 \cdot 8H_2O$	1.148	0.91	17.96	"
	1.71	74.27	"	1.108	0.84	12.78	"
	1.51	63.71	"	1.079	0.81	8.96	"
	1.41	56.30	"	1.059	0.79	6.29	"
	1.27	46.97	"	1.033	0.78	4.45	"



## STRONTIUM HYDROXIDE 682

SOLUBILITY OF STRONTIUM HYDROXIDE IN AQUEOUS SOLUTIONS AT 25°.  
(Rothmund, 1910.)

Aqueous Solution of:	Mols. Sr(OH) <sub>2</sub> · 8H <sub>2</sub> O per Liter.	Gms. Sr(OH) <sub>2</sub> per Liter.	Aqueous Solution of:	Mols. Sr(OH) <sub>2</sub> · 8H <sub>2</sub> O per Liter.	Gms. Sr(OH) <sub>2</sub> per Liter.
Water alone	0.0835	10.16	0.5 % Glycerol	0.0922	11.21
0.5 % Methyl Alcohol	0.0820	9.97	" Glycerol	0.1094	13.31
" Ethyl Alcohol	0.0744	9.05	" Mannitol	0.1996	24.29
" Propyl Alcohol	0.0708	8.61	" Urea	0.0820	9.97
" Amyl Alcohol (tertiary)	0.0630	7.66	" Ammonia	0.0785	9.55
" Acetone	0.0692	8.42	" Dimethylamine	0.0586	7.13
" Ether	0.0645	7.85	" Pyridine	0.0694	8.44

\* Data for equilibrium in the system strontium hydroxide, phenol and water at 25° are given by van Meurs (1916).

## STRONTIUM IODATE Sr(IO<sub>3</sub>)<sub>2</sub>.

100 gms. H<sub>2</sub>O dissolve 0.026 gm. at 15°, and 0.72-0.91 gm. at 100°.  
(Gay-Lussac; Rammelsberg, 1834)

## STRONTIUM IODIDE SrI<sub>2</sub>·6H<sub>2</sub>O.

### SOLUBILITY IN WATER.

(Average curve from the results of Kremers, 1858; and Etard, 1874.)

°.	Gms. SrI <sub>2</sub> per 100 Gms. Solution.	Water.	Solid Phase.	°.	Gms. SrI <sub>2</sub> per 100 Gms. Solution.	Water.	Solid Phase.
0	62.3	165.3	SrI <sub>2</sub> ·6H <sub>2</sub> O	90	78.5	365.2	SrI <sub>2</sub> ·H <sub>2</sub> O
20	64.0	177.8	"	100	79.3	383.1	"
40	65.7	191.5	"	120	80.7	418.1	"
60	68.5	217.5	"	140	82.5	471.5	"
80	73.0	270.4	"	175	85.6	594.4	"

Transition temperature about 90°. Sp. Gr. of sat. solution at 20° = 2.15  
100 gms. sat. solution of strontium iodide in absolute alcohol contain 2.6 gms. SrI<sub>2</sub> at -20°, 3.1 gms. at +4°, 4.3 gms. at 39°, and 4.7 gms. at 82°. (Etard, 1874.)  
Data for equilibrium in the system strontium iodide, strontium oxide and water at 25° are given by Milikau (1916).

## STRONTIUM PerIODIDE SrI<sub>4</sub>.

Data for the formation of strontium periodide in aqueous solution at 25° are given by Herz and Bulla (1911). The experiments were made by adding iodine to aqueous solutions of SrI<sub>2</sub> and agitating with carbon tetrachloride. From the iodine content of the CCl<sub>4</sub> layer the amount of iodine in the aqueous layer can be calculated on the basis of the distribution ratio of iodine between water and CCl<sub>4</sub>. This furnishes the necessary data for calculating the amount of the strontium periodide existing in the aqueous layer.

## STRONTIUM IODOMERCURATE SrI<sub>2</sub>·HgI<sub>2</sub>·8H<sub>2</sub>O.

A saturated aqueous solution prepared by adding SrI<sub>2</sub> and HgI<sub>2</sub> in excess to warm water and filtering when the temperature had fallen to 16.5° was found to have the composition 1.0 SrI<sub>2</sub>·1.24 HgI<sub>2</sub>·18.09 H<sub>2</sub>O. The *d*<sub>4</sub> was 2.5  
(Dubois, 1906.)



**STRONTIUM MALATE**  $\text{SrC}_4\text{H}_4\text{O}_6$ .SOLUBILITY IN WATER.  
(Cantoni and Basadonna, 1906.)

t°.	Gms. per 100 cc. Solution.	t°.	Gms. per 100 cc. Solution.	t°.	Gms. per 100 cc. Solution.
20	0.448	40	1.385	55	2.460
25	0.550	45	1.743	60	2.821
30	0.752	50	2.098	65	3.148
35	1.036			70	3.360

**STRONTIUM MALONATE**  $\text{CH}_2(\text{COO})_2\text{Sr}$ .SOLUBILITY IN WATER.  
(Cantoni and Diotallevi, 1905.)

t°.	Gms. per 100 cc. Sat. Sol.	t°.	Gms. per 100 cc. Sat. Sol.	t°.	Gms. per 100 cc. Sat. Sol.
0	0.541	25	0.521	40	0.464
10	0.540	30	0.499	45	0.453
20	0.532	35	0.478	50	0.443

**STRONTIUM MOLYBDATE**  $\text{SrMoO}_4$ .100 gms.  $\text{H}_2\text{O}$  dissolve 0.0104 gm.  $\text{SrMoO}_4$  at 17°.

(Smith and Bradbury, 1891.)

**STRONTIUM NITRATE**  $\text{Sr}(\text{NO}_3)_2$ .SOLUBILITY IN WATER.  
(Berkeley and Appleby, 1911.)

t°.	d <sub>4</sub> of Sat. Sol.	Gms. $\text{Sr}(\text{NO}_3)_2$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	d <sub>4</sub> of Sat. Sol.	Gms. $\text{Sr}(\text{NO}_3)_2$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
0.58	1.28561	40.124	$\text{Sr}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	30.74	1.51282	90.086	$\text{Sr}(\text{NO}_3)_2$
14.71	1.30380	60.867	"	47.73	1.51150	91.446	"
26.40	1.48831	82.052	"	61.34	1.51048	93.856	"
29.06	1.51098	87.648	"	68.06	1.51057	95.576	"
29.3*	...	...	" + $\text{Sr}(\text{NO}_3)_2$	78.98	1.51091	97.865	"
30.28	1.51441	88.577	$\text{Sr}(\text{NO}_3)_2$	88.04	1.51174	100.136	"
32.58	1.51408	88.943	"				

The determinations were made with very great accuracy.

SOLUBILITY OF STRONTIUM NITRATE IN AQUEOUS ALCOHOL AT 25°.  
(D'Ans and Siegler, 1913.)

Wt. % $\text{C}_2\text{H}_5\text{OH}$ in Solvent.	Gms. per 100 Gms. Sat. Sol. $\text{C}_2\text{H}_5\text{OH}$ .	Gms. $\text{Sr}(\text{NO}_3)_2$ .	Solid Phase.	Wt. % $\text{C}_2\text{H}_5\text{OH}$ in Solvent.	Gms. per 100 Gms. Sat. Sol. $\text{C}_2\text{H}_5\text{OH}$ .	Gms. $\text{Sr}(\text{NO}_3)_2$ .	Solid Phase.
0	0	44.25	$\text{Sr}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	10	6	40.05	$\text{Sr}(\text{NO}_3)_2$ (unstable)
4	1.7	42.8	"	15.05	9.5	36.7	" (unstable)
6	2.6	42.1	"	18.8*	12.35	34.3	" + $\text{Sr}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$
10.8	4.95	40.4	"	20.6	13.8	33.2	$\text{Sr}(\text{NO}_3)_2$
16	7.95	37.6	"	40.65	32.35	20.5	"
20*	12.35	34.3	" + $\text{Sr}(\text{NO}_3)_2$	59.9	53.6	10.5	"
0	0	46.6	$\text{Sr}(\text{NO}_3)_2$ (unstable)	79.2	77.15	2.6	"
6	3.45	42.7	"	99.4	99.38	0.02	"

\* Tr. pt.

100 cc. anhydrous hydrazine dissolve 5 gms.  $\text{Sr}(\text{NO}_3)_2$  at room temp.

(Welsh and Brodermon, 1915.)

**STRONTIUM NITRITE**  $\text{Sr}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$ .

100 cc. sat. solution in water contain 62.83 gms.  $\text{Sr}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$  at 19.5°.  
 " " " " 90% alcohol " 0.42 " " 20°.  
 " " " " abs. alcohol " 0.04 " " 20°.  
 (Vogel, 1903.)



SOLUBILITY OF STRONTIUM NITRITE IN WATER.  
(Oswald, 1912, 1914.)

°.	Gms. $\text{Sr}(\text{NO}_2)_2$ per 100 Gms. Sat. Sol.	Solid Phase.	°.	Gms. $\text{Sr}(\text{NO}_2)_2$ per 100 Gms. Sat. Sol.	Solid Phase.
- 1.3	11.3	Ice	35	43.1	$\text{Sr}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$
- 3.1	19.6	"	52.5	46.5	"
- 7.7	35.5	"	60.5	49.3	"
- 6.8	32.8	" + $\text{Sr}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$	65.5	50.7	"
- 2.3	33.4	$\text{Sr}(\text{NO}_2)_2 \cdot \text{H}_2\text{O}$	82.5	54	"
- 0.3	34.5	"	92	56.6	"
+ 19	39.3*	"	98	58.1	"

\*  $d = 1.4461$ .

**STRONTIUM OXALATE**  $\text{SrC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ .

One liter of water dissolves 0.0328 gm.  $\text{SrC}_2\text{O}_4$  at 1.35°, 0.0444 gm. at 15.9°, 0.0461 gm. at 18°, 0.0575 gm. at 31.7° and 0.0617 gm. at 37.3°, determined by the conductivity method. (Kohlrausch, 1903.)

One liter of sat. aqueous solution contains 0.057 gm.  $\text{SrC}_2\text{O}_4$  at 0°, 0.077 gm. at 20° and 0.093 gm. at 40°. (Cantoni and Distefani, 1905.)

SOLUBILITY OF STRONTIUM OXALATE IN AQUEOUS ACETIC ACID SOLUTIONS  
AT 26°-27°.  
(Herz and Muhs, 1903.)

Normality of Acetic Acid.	Gms. per 100 cc. Solution.		Normality of Acetic Acid.	Gms. per 100 cc. Solution.	
	$\text{CH}_3\text{COOH}$ .	$\text{SrC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ .		$\text{CH}_3\text{COOH}$ .	$\text{SrC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ .
0	0	0.009	3.86	23.16	0.0598
0.58	3.48	0.0526	5.79	34.74	0.0496
1.45	8.70	0.0622	16.26	97.56	0.0060
2.89	17.34	0.0642			

**STRONTIUM OXIDE**  $\text{SrO}$ .

Fused  $\text{SrCl}_2$  dissolves 18.3 gms.  $\text{SrO}$  per 100 gms. of the fused melt at 910°. (Arndt, 1907.)

**STRONTIUM PERMANGANATE**  $\text{Sr}(\text{MnO}_4)_2$ .

100 gms. of the sat. solution in water contain about 2.5 gms.  $\text{Sr}(\text{MnO}_4)_2$  at 0°. (Patterson, 1906.)

**STRONTIUM SALICYLATE**  $(\text{C}_6\text{H}_4\text{OH} \cdot \text{COO})_2\text{Sr} \cdot 2\text{H}_2\text{O}$ .

100 gms. sat. solution in water contain 3.04 gms.  $(\text{C}_6\text{H}_4\text{OH} \cdot \text{COO})_2\text{Sr}$  at 15° and 20.44 gms. at 100°. (Tarugi and Checchi, 1901.)

SOLUBILITY OF STRONTIUM SALICYLATE IN AQUEOUS ALCOHOL AT 25°.  
(Seidell, 1909, 1910.)

Wt. % $\text{C}_2\text{H}_5\text{OH}$ in Solvent.	$d_{25}$ of Sat. Sol.	Gms. $(\text{C}_6\text{H}_4\text{OH} \cdot \text{COO})_2\text{Sr} \cdot 2\text{H}_2\text{O}$ per 100 Gms. Sat. Sol.	Wt. % $\text{C}_2\text{H}_5\text{OH}$ in Solvent.	$d_{25}$ of Sat. Sol.	Gms. $(\text{C}_6\text{H}_4\text{OH} \cdot \text{COO})_2\text{Sr} \cdot 2\text{H}_2\text{O}$ per 100 Gms. Sat. Sol.
0	1.022	5.04	60	0.923	7.15
10	1.006	4.88	70	0.893	5.90
20	0.993	5.22	80	0.859	4.40
30	0.982	6.20	90	0.824	2.56
40	0.966	7.70	92.3	0.815	2.02
50	0.948	8.08	100	0.790	0.44

The solid phase was  $(\text{C}_6\text{H}_4\text{OH} \cdot \text{COO})_2\text{Sr} \cdot 2\text{H}_2\text{O}$  in all cases except the solution in 100 per cent alcohol, in which partial dehydration and conversion of the crystalline salt to an amorphous bulky white powder occurred.



**STRONTIUM SUCCINATE**  $C_4H_4O_6Sr$ .

100 gms. sat. solution in water contain 0.439 gm.  $C_4H_4O_6Sr$  at 15° and 0.215 gm. at 100°.

(Tarugi and Checchi, 1901.)

**SOLUBILITY OF STRONTIUM SUCCINATE IN WATER.**

(Cantoni and Diotalevi, 1905.)

t°.	Gms. $C_4H_4O_6Sr$ per 100 cc. Sat. Sol.	t°.	Gms. $C_4H_4O_6Sr$ per 100 cc. Sat. Sol.	t°.	Gms. $C_4H_4O_6Sr$ per 100 cc. Sat. Sol.
0	0.052	20	0.270	40	0.375
5	0.076	25	0.382	45	0.389
10	0.111	30	0.451	50	0.424
15	0.177	35	0.413		

**STRONTIUM SULFATE**  $SrSO_4$ .

One liter of water dissolves 0.1133 gm.  $SrSO_4$  at 2.85°, 0.1143 gm. at 17.4° and 0.1143 gm. at 32.3°, determined by the conductivity method. (Kohlrausch, 1908.)

**SOLUBILITY OF STRONTIUM SULFATE IN AQUEOUS SOLUTIONS OF AMMONIUM ACETATE AT 25°.**

(Marden, 1916.)

Gms. per 100 Gms. Sat. Sol.		Gms. per 100 Gms. Sat. Sol.	
$CH_3COONH_4$ .	$SrSO_4$ .	$CH_3COONH_4$ .	$SrSO_4$ .
0	0.0151	10.68	0.0942
2.13	0.0451	21.37	0.115
5.34	0.0732		

**SOLUBILITY OF STRONTIUM SULFATE IN AQUEOUS CALCIUM NITRATE AT ROOM TEMPERATURE**

(Raffo and Rossi, 1915.)

Analyzed solutions of  $Sr(NO_3)_2$ ,  $Ca(NO_3)_2$  and  $CaSO_4$  were mixed at 60° and allowed to stand at room temperature 1 to 2 days. The resulting  $SrSO_4$  was determined and the difference between the amount found and the amount which would have resulted if all the  $Sr(NO_3)_2$  had been converted to  $SrSO_4$  was taken as the amount of  $SrSO_4$  dissolved. Gradually increasing concentrations of  $Ca(NO_3)_2$  were used.

Gms. per 100 cc. Sat. Sol.		Gms. per 100 cc. Sat. Sol.	
$Ca(NO_3)_2$ .	$SrSO_4$ .	$Ca(NO_3)_2$ .	$SrSO_4$ .
0.5	0.0483	4	0.1489
1	0.0619	5	0.1698
2	0.1081	6	0.1955
3	0.1275		

**SOLUBILITY OF STRONTIUM SULFATE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC, NITRIC, CHLORACETIC AND FORMIC ACIDS.**

(Banthisch, 1884.)

cc. of Aq. Acid containing 1 Mg. Equiv. in each case.	In Aq. HCl		In Aq. $HNO_3$		In Aq. $CH_2ClCOOH$		In Aq. $HCOOH$	
	Gms. per 100 cc. Sol.		Gms. per 100 cc. Sol.		Gms. per 100 cc. Sol.		Gms. per 100 cc. Sol.	
	HCl.	$SrSO_4$ .	$HNO_3$ .	$SrSO_4$ .	$CH_2Cl$ COOH.	$SrSO_4$ .	$HCOOH$ .	$SrSO_4$ .
0.2	18.23	0.161	31.52	0.381	...	...	...	...
0.5	7.29	0.207	12.61	0.307	...	...	...	...
1.0	3.65	0.188	6.30	0.217	94.47	0.026	46.02	0.024
2.0	1.82	0.126	3.15	0.138	47.23	0.022	...	...
10.0	0.36	0.048	0.63	0.049	...	...	...	...

100 gms. 95 per cent formic acid dissolve 0.02 gm.  $SrSO_4$  at 18.5°. (Aschan, 1913.)



## STRONTIUM SULFATE

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### SOLUBILITY OF STRONTIUM SULFATE IN AQUEOUS SODIUM CARBONATE AT 25°.

(Herz, 1910.)

Freshly prepared and dried  $\text{SrSO}_4$  was shaken 5 days with aqueous sodium carbonate solutions and the supernatant clear solutions analyzed.

Normality of Aqueous $\text{Na}_2\text{CO}_3 \left( \frac{\text{Na}_2\text{CO}_3}{2} \right)$ .	Gm. Mols. per Liter Sat. Sol.	
	$\frac{\text{Na}_2\text{CO}_3}{2}$ .	$\frac{\text{Na}_2\text{SO}_4}{2}$ .
0.6025	0.0382	0.5643
1.205	0.076	1.129
2.41	0.153	2.257

### SOLUBILITY OF STRONTIUM SULFATE IN SULFURIC ACID SOLUTIONS.

t°.	Conc. of $\text{H}_2\text{SO}_4$ .	Gms. $\text{SrSO}_4$ per 100 Gms. Acid.	Authority.
ord.	concentrated	5.68	(Sturve, 1870.)
"	fuming	9.77	"
"	91%	0.08	(Varenne and Paulsen, 1881.)
70	Sp. Gr. 1.843 = 99%	14	(Garside, 1875.)
ord.	Absolute $\text{H}_2\text{SO}_4$	21.7*	(Bergius, 1910.)

\* per 100 cc. Sat. Sol.

### SOLUBILITY OF STRONTIUM SULFATE IN AQUEOUS SALT SOLUTIONS.

(Virck, 1862.)

In Aq. NaCl.		In Aq. KCl.		In Aq. $\text{MgCl}_2$ .		In Aq. $\text{CaCl}_2$ .	
(a.)	(b.)	(a.)	(b.)	(a.)	(b.)	(a.)	(b.)
8.44	0.165	8.22	0.193	1.59	0.199	8.67	0.176
15.54	0.219	12.54	0.193	4.03	0.206	16.51	0.185
22.17	0.181	18.08	0.251	13.63	0.242	33.70	0.171

(a) = Gms. salt per 100 gms. aq. solution. (b) = Gms.  $\text{SrSO}_4$  per 100 gms. solvent.

## STRONTIUM TARTRATE $\text{SrC}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$ .

### SOLUBILITY IN WATER.

(Cantoni and Zachoder, 1905.)

t°.	Gms. $\text{SrC}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$ per 100 cc. Solution.	t°.	Gms. $\text{SrC}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$ per 100 cc. Solution.	t°.	Gms. $\text{SrC}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$ per 100 cc. Solution.
0	0.112	25	0.224	60	0.486
10	0.149	30	0.252	70	0.580
15	0.174	40	0.328	80	0.688
20	0.200	50	0.407	85	0.755

### SOLUBILITY OF STRONTIUM TARTRATE IN AQUEOUS SOLUTIONS OF ACETIC ACID AT 26°-27°.

(Herz and Muhs, 1903.)

Normality of Acetic Acid.	Gms. per 100 cc. Solution.		Normality of Acetic Acid.	Gms. per 100 cc. Solution.	
	$\text{CH}_3\text{COOH}$ .	$\text{SrC}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$ .		$\text{CH}_3\text{COOH}$ .	$\text{SrC}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$ .
0	0	0.227	3.77	21.85	1.051
0.565	3.39	0.678	5.65	33.90	0.982
1.425	8.15	0.864	16.89	101.34	0.184
2.85	17.10	0.996			

## STRONTIUM (Di) TUNGSTATE $\text{SrW}_2\text{O}_7 \cdot 3\text{H}_2\text{O}$ .

100 cc.  $\text{H}_2\text{O}$  dissolve 0.35 gm. at 15°.

(Lefort, 1878.)



**STRYCHNINE**  $C_{21}H_{22}N_2O_2$ .

## SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	°.	Gms. $C_{21}H_{22}N_2O_2$ per 100 Gms. Solvent.	Solvent.	°.	Gms. $C_{21}H_{22}N_2O_2$ per 100 Gms. Solvent.
Water	ord. t.	0.014 (1)	Carbon Tetrachloride	20	0.158 (5)
	20	0.0125 (2)	" "	20	0.22 (9)
	20	0.0143 (3)	" "	17	0.645 (10)
	25	0.016 (4)	Chloroform	25	10.25 (6)
	20	0.021 (5)	" "	25	16.6 (14)
	20	0.033 (3)	Diethylamine	20	1.7 (3)
0% $NH_3$			Ethyl Acetate	20	0.197 (5)
5% $H_2BO_3$ in 50% Glycerol	ord. t.	3.5 (1)	Ether	20	0.043 (5)
10% $NH_3$	15-20	0.71 (7)	" sat. with $H_2O$	25	0.018 (5)
( $d=0.83$ )	20	0.833 (3)	" "	20	0.051 (5)
( $d=0.83$ )	25	0.91 (4)	Glycerol	15	0.25
" + 10% $NH_3$	20	0.256 (3)	Petroleum Ether	20	0.0093 (5)
( $d=0.785$ )	25	0.70 (6)	Piperidine	20	0.7 (3)
10% $NH_3$ ( $d=0.796$ )	25	0.49 (6)	Pyridine	20	1.5 (3)
15% "	20	20 (3)	" "	26	1.24 (11)
20% Alcohol	25	0.55 (4)	Aq. 50 % Pyridine	20-25	2.43 (8)
25% "	20	0.77 (5)	Water sat. with Ether	20	0.017 (5)
30% "	25	0.76 (6)	Oil of Sesame	20	0.061 (2)

Baroni and Barlinetto (1911); (2) Zalai (1910); (3) Scholtz (1912); (4) U. S. P. 8th ed.; (5) Müller; (6) Schaefer (1913); (7) Squire and Caines (1905); (8) Dehn (1917); (9) Gori (1913); (10) Elmeyer (1901); (11) Holky (1905).

## SOLUBILITY OF STRYCHNINE IN AQUEOUS ALCOHOL AT 15°-20°.

(Squire and Caines, 1905.)

Per cent Alcohol in Solvent	20	45	60	70	90
Gms. $C_{21}H_{22}N_2O_2$ per 100 cc. solvent	0.024	0.125	0.25	0.40	0.59

## SOLUBILITY OF STRYCHNINE IN MIXTURES OF ETHER AND CHLOROFORM AT 25°.

(Marden and Dover, 1916.)

Per cent $CHCl_3$ in Mixed Solvent.	Gms. $C_{21}H_{22}N_2O_2$ per 100 Gms. Mixed Solvent.	Per cent $CHCl_3$ in Mixed Solvent.	Gms. $C_{21}H_{22}N_2O_2$ per 100 Gms. Mixed Solvent.
100	15.3	50	0.35
90	7.1	30	0.21
80	2.77	20	0.15
70	1.5	10	0.09
60	0.65	0	0.02

## SOLUBILITY OF STRYCHNINE IN MIXED SOLVENTS AT 25°.

(Schaefer, 1913.)

Mixture.	Gm. $C_{21}H_{22}N_2O_2$ per 100 cc. of Mixture.
One volume of $C_2H_5OH$ + 4 vols. $CHCl_3$	25
One volume of $C_2H_5OH$ + 4 vols. $C_6H_6$	5
One volume of $CH_3OH$ + 4 vols. $CHCl_3$	25
One volume of $CH_3OH$ + 4 vols. $C_6H_6$	6.7

## DISTRIBUTION OF STRYCHNINE BETWEEN WATER AND CHLOROFORM AT 25°.

(Seidell, 1910a.)

$C_{21}H_{22}N_2O_2$ Added 15 cc. $H_2O$ + 15 cc. $CHCl_3$ .	Gms. $C_{21}H_{22}N_2O_2$ Recovered per 15 cc:		(b) (a)
	$H_2O$ Layer (a).	$CHCl_3$ Layer (b).	
0.005	0.0006	0.0103(?)	...
0.025	0.0010	0.0253	25.2
0.125	0.0021	0.1209	61
0.625	0.0099	0.6225	64



**STRYCHNINE**

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**STRYCHNINE ARSENATE**  $C_{21}H_{22}N_2O_7 \cdot H_3AsO_4 \cdot \frac{1}{2}H_2O \cdot (1\frac{1}{2}H_2O)$ .100 gms. sat. solution in water contain 4.53 gms.  $C_{21}H_{22}N_2O_7 \cdot H_3AsO_4$  at 25°.100 gms.  $CHCl_3$  dissolve 0.085 gm.  $C_{21}H_{22}N_2O_7 \cdot H_3AsO_4$  at 15°.**STRYCHNINE FORMATE**  $C_{21}H_{22}N_2O_7 \cdot HCOOH \cdot 2H_2O$ .SOLUBILITY IN WATER AND IN ALCOHOL.  
(Hampshire and Pratt, 1913.)

Solubility in Water.		Solubility in Abs. Alcohol.	
t°.	Gms. Salt per 100 Gms. $H_2O$ .	t°.	Gms. Salt per 100 Gms. $C_2H_5OH$ .
19.5	30.59	18.5	10
24	39.68	20	10.3
27	44.25	22	10.64

**STRYCHNINE HYDROBROMIDE**  $C_{21}H_{22}N_2O_7 \cdot HBr$ .100 cc.  $H_2O$  dissolve 1.54 gms. of the salt at 15°-20°.

100 cc. 90% alcohol dissolve 1.04 gm. of the salt at 15°-20°.

**STRYCHNINE HYDROCHLORIDE**  $C_{21}H_{22}N_2O_7 \cdot HCl$ .100 cc.  $H_2O$  dissolve 2.86 gms. of the salt at 15°-20°.

100 cc. 90% alcohol dissolve 1.37 gms. of the salt at 15°-20°.

100 gms.  $CHCl_3$  dissolve 0.592 gm. of the salt at 15°.**STRYCHNINE NITRATE**  $C_{21}H_{22}N_2O_7 \cdot HNO_3$ .

SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. Salt per 100 cc. Solvent.	Solvent.	t°.	Gms. Salt per 100 cc. Solvent.
Water	15	1.4 (1)	$CH_3OH$	25	0.345 (3)
"	15-20	1.6 (2)	$CHCl_3$	25	1.25 (3)
"	25	2.38 (4)	1 vol. $C_2H_5OH$ + 4 vols. $CHCl_3$	25	5 (3)
"	80	12.5 (4)	1 vol. $C_2H_5OH$ + 4 vols. $C_6H_6$	25	0.66 (3)
90% $C_2H_5OH$	15-20	0.83 (2)	1 vol. $CH_3OH$ + 4 vols. $CHCl_3$	25	4 (3)
"	15	0.77 (1)	1 vol. $CH_3OH$ + 4 vols. $C_6H_6$	25	1 (3)
"	b. pt.	3.45 (1)	Glycerol	25	1.66 (4)
100% $C_2H_5OH$	25	0.37 (3)			

(1) Dott (1910); (2) Squire and Caines (1905); (3) Schaefer (1913); (4) U. S. P. VIII ed.

**DISTRIBUTION OF STRYCHNINE NITRATE BETWEEN WATER AND CHLOROFORM AT 25°.**

(Seidell, 1928.)

Gms. $C_{21}H_{22}N_2O_7 \cdot HNO_3$ Added per 15 cc. $H_2O$ + 15 cc. $CHCl_3$ .	Gms. $C_{21}H_{22}N_2O_7 \cdot HNO_3$ per 15 cc.:		$\frac{a}{b}$ .
	$H_2O$ Layer (a).	$CHCl_3$ Layer (b).	
0.005	0.0051	0.0030 (?)	...
0.025	0.0222	0.0042	5.3
0.125	0.1017	0.0243	4.2
0.625	0.3250	0.1698	2

**STRYCHNINE OXALATE**100 gms.  $H_2O$  dissolve 1.13 gms. of the anhydrous salt at about 15°.

(Dott, 1910.)

**STRYCHNINE PERCHLORATE**  $C_{21}H_{22}N_2O_7 \cdot HClO_4$ .100 gms.  $H_2O$  dissolve 0.022 gm. perchlorate at 15°.

(Hofmann, Roth, Höbold and Metzler, 1910.)



**STRYCHNINE SULFATE**  $(C_{21}H_{22}N_2O_3)_2 \cdot H_2SO_4 \cdot 5H_2O$ .

## SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. Salt per 100 cc. Solvent.	Solvent.	t°.	Gms. Salt per 100 cc. Solvent.
Water	15-20	2.08 (1)	CHCl <sub>3</sub>	15	0.05 (4)
"	25	3.23 (2)	"	25	0.31 (2)
"	80	16.6 (2)	"	25	0.43 (3)
90% C <sub>2</sub> H <sub>5</sub> OH	15-20	0.74 (1)	1 vol. C <sub>2</sub> H <sub>5</sub> OH+4 vols. CHCl <sub>3</sub>	25	12.8 (3)
94% "	25	1.9 (2)	1 vol. C <sub>2</sub> H <sub>5</sub> OH+4 vols. C <sub>6</sub> H <sub>6</sub>	25	0.725 (3)
94% "	60	6.2 (2)	1 vol. CH <sub>3</sub> OH+4 vols. CHCl <sub>3</sub>	25	25 (3)
100% "	25	0.8 (3)	1 vol. CH <sub>3</sub> OH+4 vols. C <sub>6</sub> H <sub>6</sub>	25	12.5 (3)
CH <sub>3</sub> OH	25	8.33 (3)	Glycerol	15	18 (2)

(1) Squire and Caines (1905); (2) U. S. P. VIII; (3) Schaefer (1913); (4) Hill (1910).

**STRYCHNINE TARTRATE**SOLUBILITY OF *d*, *l* AND OF RACEMIC STRYCHNINE TARTRATE IN WATER.  
(Dutilh, 1912.)

t°.	Gms. of Each Separately per 1000 gms. H <sub>2</sub> O.		
	<i>d</i> Tartrate.	<i>l</i> Tartrate.	Racemic Tartrate.
7.35	14.14	9.48	14.02
16	17.72	11.50	19.12
25	22.9	14.52	24.70
27	...	15.60	...
30	...	17.02	...
40	35.18	22.90	38.42

SOLUBILITY OF MIXTURES OF *d* AND *l* TARTRATES AND OF RACEMIC STRYCHNINE TARTRATE IN WATER.  
(Ladenburg and Doctor, 1899.)

Results for <i>d</i> + <i>l</i> Tartrate.			Results for Racemic Tartrate.		
t°.	Gms. Anhydrous Salt per 100 Gms. H <sub>2</sub> O.	Solid Phase.	t°.	Gms. Anhydrous. Salt per 100 Gms. H <sub>2</sub> O.	Solid Phase.
7	1.48	50% <i>d</i> + 5% <i>l</i>	7	1.39	Racemic Tartrate
19	1.95	"	19	1.90	"
27	2.38	"	27	2.33	"
35	3.02	"	35	3.17	"
42	3.75	"	42	3.92	"

100 gms. sat. solution in water contain 0.45 gm. anhydrous strychnine acid tartrate at about 15°.  
(Dott, 1910.)**SUBERIC ACID**  $C_6H_{12}(COOH)_2$ .

## SOLUBILITY IN WATER.

(Lamoureux, 1899.)

t°.	0°.	15°.	20°.	35°.	50°.	65°.
Gms. C <sub>6</sub> H <sub>12</sub> (COOH) <sub>2</sub> per 100 cc. sol.	0.08	0.13	0.16	0.45	0.98	2.22

## SOLUBILITY OF SUBERIC ACID IN ALCOHOLS AT 4°.

(Timofeiew, 1894.)

Alcohol.	Gms. C <sub>6</sub> H <sub>12</sub> (COOH) <sub>2</sub> per 100 Gms.	
	Sat. Sol.	Alcohol.
Methyl Alcohol	20.32	32.04
Ethyl Alcohol	15.5	18.44
Propyl Alcohol	12.2	13.9

100 gms. 95 per cent formic acid dissolve 2.13 gms. C<sub>6</sub>H<sub>12</sub>(COOH)<sub>2</sub> at 19.5°.Data for the distribution of suberic acid between water and ether at 25° are given by Chandler, 1908.  
(Aschan, 1913.)



# SUCCINIC ACID

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## SUCCINIC ACID $(\text{CH}_2)_2(\text{COOH})_2$ .

### SOLUBILITY IN WATER.

(Miczynski, 1886; van der Stadt, 1902; Lamouroux, 1899; for other concordant results, see Bougna, 1874; Henry, 1884.)

t°.	Gms. (CH <sub>2</sub> ) <sub>2</sub> (COOH) <sub>2</sub> per 100		Gms. Succinic Anhydride (CH <sub>2</sub> ) <sub>2</sub> COCO per 100 Gms. H <sub>2</sub> O.	Mol. Per cent.	
	Gms. H <sub>2</sub> O.	cc. Solution.		H <sub>2</sub> O.	(CH <sub>2</sub> ) <sub>2</sub> COCO.
0	2.80	2.78 (L.)	2.34	99.58	0.42
10	4.51	4	3.80	99.32	0.68
20	6.89	5.8	5.77	98.97	1.03
25	8.06	7	6.74	98.80	1.20
30	10.58	8.5	8.79	98.44	1.56
40	16.21	12.5	13.42	97.64	2.36
50	24.42	18	19.95	96.53	3.47
60	35.83	24.5	28.77	95.07	4.93
70	51.07	...	40.11	93.26	6.74
80	70.79	...	54.08	91.12	8.88
89.4	95.41	...	70.62	88.71	11.29
104.8	146.3	...	101.2	84.57	15.43
115.1	188.5	...	126.8	81.4	18.6
134.2	335.4	...	187.8	74.72	25.28
159.5	748.2	...	295.2	65.27	34.73
180.6	1839	...	408.5	57.6	42.4
182.8	∞	...	542.3	50	50
174.4	...	...	808.5	40.7	59.3
153.3	...	...	2239	19.86	80.14
128	...	...	8865.	5.89	94.11
118.8-119	...	...	∞	0	100

The following very careful determinations of the solubility of succinic acid in water are given by Marshall and Bain (1910).

t°.	0°.	12.5°.	25°.	37.5°.	50°.	62.5°.	75°.
Gms. $(\text{CH}_2)_2(\text{COOH})_2$ per 100 gms. $\text{H}_2\text{O}$	2.75	4.92	8.35	14	23.83	39.35	60.37

### SOLUBILITY OF SUCCINIC ACID IN AQUEOUS SOLUTIONS OF SALTS AND OF ACIDS AT 25°.

(Herz, 1910b, 1911.)

In Aq. HBr.		In Aq. HCl.		In Aq. KBr.		In Aq. KCl.	
Gms. per Liter.		Gms. per Liter.		Gms. per Liter.		Gms. per Liter.	
HBr.	$\text{C}_2\text{H}_5\text{O}_4$ .	HCl.	$\text{C}_2\text{H}_5\text{O}_4$ .	KBr.	$\text{C}_2\text{H}_5\text{O}_4$ .	KCl.	$\text{C}_2\text{H}_5\text{O}_4$ .
0	81.21	18.45	66.25	0	81.21	28.34	75.58
79.3	57.38	45.6	50.78	65.45	75.58	77.56	74.39
274.4	32.83	87.9	35.42	260.5	69.68	150.7	69.68
		166.6	27.75	502.1	62.59	267	61.41

In Aq. KI.		In Aq. LiCl.		In Aq. NaCl.		Solid Phase.
Gms. per Liter.		Gms. per Liter.		Gms. per Liter.		
KI.	C <sub>2</sub> H <sub>5</sub> O <sub>4</sub> .	LiCl.	C <sub>2</sub> H <sub>5</sub> O <sub>4</sub> .	NaCl.	C <sub>2</sub> H <sub>5</sub> O <sub>4</sub> .	C <sub>2</sub> H <sub>5</sub> O <sub>4</sub> .
0	81.21	0	81.21	18.7	74.39	"
46.48	79.12	7.63	70.86	32.73	69.68	"
102.9	77.93	23.32	62.59	64.3	61.41	"
		57.66	47.24	132.1	49.55	"
		117	29.51	289.4	27.16	"
		176.4	20.07	315.1	22.44	NaCl
		231.5	14.17	318	4.72	"



SOLUBILITY OF SUCCHINIC ACID IN AQUEOUS SOLUTIONS OF POTASSIUM  
SUCCHINATE AND VICE VERSA AT SEVERAL TEMPERATURES.

(Marshall and Cameron, 1907.)

t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.	t°.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
	$\text{H}_2\text{C}_4\text{H}_4\text{O}_4$	$\text{K}_2\text{C}_4\text{H}_4\text{O}_6$			$\text{H}_2\text{C}_4\text{H}_4\text{O}_4$	$\text{K}_2\text{C}_4\text{H}_4\text{O}_6$	
0	2.71	0	$\text{H}_2\text{C}_4\text{H}_4\text{O}_4$	25	7.88	0	$\text{H}_2\text{C}_4\text{H}_4\text{O}_4$
0	7.26	8.09	" + $\text{KH}_2(\text{C}_4\text{H}_4\text{O}_4)_2$	25	9.965	3.17	"
0	7.86	7.66	"	25	12.77	8.4	"
0	8.24	9.95	$\text{KH}_2(\text{C}_4\text{H}_4\text{O}_4)_2$	25	17.6	14.15	"
0	8.11	12.77	"	25	18.1	14.3	" + $\text{KH}_2(\text{C}_4\text{H}_4\text{O}_4)_2$
0	7.87	15.47	" + $\text{KHC}_4\text{H}_4\text{O}_4 \cdot 2\text{H}_2\text{O}$	25	15.36	18.48	$\text{KH}_2(\text{C}_4\text{H}_4\text{O}_4)_2$
0	0	40.2	$\text{K}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$	25	13.7	23.6	" + $\text{KHC}_4\text{H}_4\text{O}_4$
14	1.468	41.3	$\text{K}_2\text{C}_4\text{H}_4\text{O}_6 + \text{KHC}_4\text{H}_4\text{O}_4$	25	13.06	23.81	$\text{KHC}_4\text{H}_4\text{O}_4$
			+ $\text{KHC}_4\text{H}_4\text{O}_4 \cdot 2\text{H}_2\text{O}$	25	11.98	24.43	"
15.9	1.7	34.36	$\text{KHC}_4\text{H}_4\text{O}_4 \cdot 2\text{H}_2\text{O} + \text{KHC}_4\text{H}_4\text{O}_4$	25	9.97	25	"
20	6.39	0	$\text{H}_2\text{C}_4\text{H}_4\text{O}_4$	25	6.61	28.6	"
20	7.48	1.85	"	25	2.6	38.2	"
20	14.63	11.64	"	25	2.11	40.6	"
20	15.03	13.32	" + $\text{KH}_2(\text{C}_4\text{H}_4\text{O}_4)_2$	25	1.03	48.7	" + $\text{K}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$
20	13.32	18.46	$\text{KH}_2(\text{C}_4\text{H}_4\text{O}_4)_2$	25	0.13	56.15	$\text{K}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$
20	12.74	22.45	" + $\text{KHC}_4\text{H}_4\text{O}_4$	25	0	58.05	"
20	11.7	22.91	$\text{KHC}_4\text{H}_4\text{O}_4$	40	12.9	0	$\text{H}_2\text{C}_4\text{H}_4\text{O}_4$
20	1.71	42.1	"	40	25.5	16.83	" + $\text{KH}_2(\text{C}_4\text{H}_4\text{O}_4)_2$
20	1.05	47.3	" + $\text{K}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$	40	19	25.48	$\text{KH}_2(\text{C}_4\text{H}_4\text{O}_4)_2 + \text{KHC}_4\text{H}_4\text{O}_4$
20	0.985	48.1	$\text{K}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$	40	15.83	26.56	$\text{KHC}_4\text{H}_4\text{O}_4$
20	0.909	48.75	"	40	0	62.10	$\text{K}_2\text{C}_4\text{H}_4\text{O}_6 \cdot 3\text{H}_2\text{O}$
20	0.159	54.3	"				
20	0	56.6	"				

SOLUBILITY OF SUCCHINIC ACID IN ALCOHOLS AND IN ETHER.

(Timofeev, 1891, 1894; at 15°, Bourgoin, 1878.)

Solvent.	Gms. $(\text{CH}_3)_2(\text{COOH})_2$ per 100 Gms. Solvent at:			
	-1°.	+15°.	+21.5°.	+39°.
Abs. Methyl Alcohol	10.51	...	19.40	28.7
Abs. Ethyl "	5.06	12.59	9.49	15
90% " "	...	7.51	...	...
Abs. Propyl "	2.11	...	4.79	7.53
Abs. Ether	...	1.265	...	...
Isobutyl Alcohol	...	...	2.73	...

100 gms. 95 per cent formic acid dissolve 2.06 gms.  $(\text{CH}_3)_2(\text{COOH})_2$  at 18.5°.  
(Aschan, 1913.)

DISTRIBUTION OF SUCCHINIC ACID BETWEEN WATER AND AMYL ALCOHOL  
AT 20°.

(Herz and Fischer, 1904.)

Millimols $\frac{1}{2}\text{C}_4\text{H}_4\text{O}_4$ per 10 cc.		Gms. $\text{C}_4\text{H}_4\text{O}_4$ per 100 cc.		Millimols $\frac{1}{2}\text{C}_4\text{H}_4\text{O}_4$ per 10 cc.		Gms. $\text{C}_4\text{H}_4\text{O}_4$ per 100 cc.	
Alcohol Layer.	Aq. Layer.	Alcohol Layer.	Aq. Layer.	Alcohol Layer.	Aq. Layer.	Alcohol Layer.	Aq. Layer.
0.1888	0.2684	0.1114	0.1584	3.899	6.0795	2.302	3.588
0.3643	0.5252	0.215	0.310	5.199	8.099	3.069	4.779
0.7077	1.0373	0.418	0.612	6.334	10.170	3.739	6
1.440	2.1266	0.850	1.255	7.119	11.555	4.202	6.821
2.715	4.0495	1.603	2.391				



# SUCCINIC ACID

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## SOLUBILITY OF SUCCINIC ACID IN AQUEOUS ACETONE AT 20°. (Herz and Knoch, 1904.)

cc. Acetone per 100 cc. Solution.	C <sub>4</sub> H <sub>4</sub> O <sub>4</sub> per 100 cc. Solution.		cc. Acetone per 100 cc. Solution.	C <sub>4</sub> H <sub>4</sub> O <sub>4</sub> per 100 cc. Solution.	
	Millimols.	Gms.		Millimols.	Gms.
0	107.8	6.363	60	275.7	16.27
10	127.4	7.519	70	278.5	16.44
20	155.8	9.194	80	265.3	15.66
30	186.7	11.02	90	201.9	11.91
40	225.4	13.30	100	51.5	3.04
50	254.3	15.01			

## SOLUBILITY OF SUCCINIC ACID IN AQUEOUS GLYCEROL SOLUTIONS AT 25°. (Herz and Knoch, 1905.)

Wt. % Glycerol in Solvent.	C <sub>4</sub> H <sub>4</sub> O <sub>4</sub> per 100 cc. Solution.		Sp. Gr. of Solutions.	Wt. % Glycerol in Solvent.	C <sub>4</sub> H <sub>4</sub> O <sub>4</sub> per 100 cc. Solution.		Sp. Gr. of Solutions.
	Millimols.	Gms.			Millimols.	Gms.	
0	133.4	7.874	1.0213	40.95	105.8	6.244	1.1120
7.15	128.2	7.566	1.0407	48.70	99.9	5.896	1.1308
20.44	118.3	6.982	1.0644	69.20	88.5	5.223	1.1804
31.55	109.7	6.476	1.0897	100*	74.6	4.440	1.2530

\* Sp. Gr. of Glycerol = 1.2555. Impurity about 1.5 per cent.

## DISTRIBUTION OF SUCCINIC ACID BETWEEN WATER AND ETHER AT 15°, 20° AND 25°. (Pinnow, 1915.)

Results at 15°.			Results at 20°.			Results at 25°.		
Gm. Mols. per Liter.		c.	Gm. Mols. per Liter.		c.	Gm. Mols. per Liter.		c.
Aqueous Layer (c).	Ether Layer (c').		Aqueous Layer (c).	Ether Layer (c').		Aqueous Layer (c).	Ether Layer (c').	
0.474	0.0783	6.05	0.644	0.096	6.71	0.3293	0.0438	7.52
0.2585	0.0415	6.23	0.312	0.046	6.87	0.1768	0.0235	7.52
0.1175	0.0187	6.28	0.151	0.0218	6.93	0.0894	0.0116	7.71
			0.0405	0.006	6.75			

Very careful determinations of this distribution at 0° and at 25°, in which the ionization of the succinic acid in the two solvents is taken into consideration, are given by Chandler, 1908. Two determinations at 0° and two at 15° are quoted by Kolossovsky, 1911. Earlier data for this system are given by Nernst, "Theoretical Chemistry," 3rd English edition, p. 496.

## BromSUCCINIC ACID CHBr(CH<sub>2</sub>)(COOH)<sub>2</sub> (m. pt. 159°).

### SOLUBILITY IN ALCOHOLS AT 22°. (Timofeiew, 1894.)

Alcohol.	Gms. CHBr(CH <sub>2</sub> )(COOH) <sub>2</sub> per 100 Gms.	
	Sat. Solution.	Alcohol.
Methyl Alcohol	56.5	129.7
Ethyl Alcohol	45.5	83.6
Propyl Alcohol	33.1	49.4

Data for the distribution of monobromsuccinic acid between water and ether at 25° and for dibromsuccinic acid between water and ether at 25° are given by Chandler (1908).

Data for the melting-points of mixtures of the following pairs of optical antipodes are given by Centnerszwer (1899).

- d + l Chlorsuccinic Acid.
- d + i Chlorsuccinic Acid.
- d Chlorsuccinic Acid + l Bromsuccinic Acid.
- i Chlorsuccinic Acid + l Bromsuccinic Acid.
- d + l Benzylaminosuccinic Acid.
- d + l Aminosuccinic Acid.



**SUCCINIMIDE**  $C_4H_4<\begin{smallmatrix} CO \\ CO \end{smallmatrix}>NH$ .**SOLUBILITY IN WATER AND IN ETHYL ALCOHOL.**

Interpolated from original results.

(Speyer, 1902.)

t°.	In Water.			In Ethyl Alcohol.		
	Wt. of 1 cc. Solution.	Mols. per 100 Mols. H <sub>2</sub> O.	Gms. per 100 Gms. H <sub>2</sub> O.	Wt. of 1 cc. Solution.	Mols. per 100 Mols. C <sub>2</sub> H <sub>5</sub> OH.	Gms. per 100 Gms. C <sub>2</sub> H <sub>5</sub> OH.
0	1.025	1.58	8.69	0.815	0.88	1.89
10	1.035	2.4	14	0.809	1.35	2.7
20	1.052	4	23	0.806	2	4.1
25	1.067	5.9	33	0.805	2.5	5.3
30	1.086	8	45	0.804	3.1	6.8
40	1.120	12.8	70	0.809	4.9	10.5
50	1.145	17.8	96	0.816	7.8	16
60	1.167	22.6	124	0.835	12.3	26.5
70	1.189	27.5	152	0.873	...	...
80	1.204	32.8	...	0.954	...	...

Freezing-point data (solubilities, see footnote, p. 1), are given for ethylsuccinimide + bromotoluene and for ethylsuccinimide + *p* xylene by Paterno and Ampola (1897).

**SUCCINIC NITRILE** (Ethylene Cyanide)  $CNCH_2CH_2CN$ .

The solubility of succinic nitrile in water and also in aqueous sodium chloride solutions at various temperatures has been determined by Schreinemakers (1897), and the results presented in terms of mols. of nitrile per 100 mols. of nitrile + H<sub>2</sub>O. The following calculations of these results to gram quantities was made by (Landolt and Börnstein's, "Tabellen" 1906.)

t°.	Gms. $CNCH_2CH_2CN$ per 100 Gms.		t°.	Gms. $CNCH_2CH_2CN$ per 100 Gms.	
	Aq. Layer.	Nitrile Layer.		Aq. Layer.	Nitrile Layer.
18.5	10.2	92	53.5	33.2	66.4
20	11	91.5	55	40.3	62.8
39	...	85.2	55.4 crit. temp.	51	
45	22	...			

Very complete data for the system succinic acid nitrile, ethyl alcohol and water, determined by the synthetic sealed-tube method, are given by Schreinemakers (1898c). Results for the system succinic acid nitrile, cane sugar and water are given by Timmermans (1907).

**SUGAR**  $C_{12}H_{22}O_{11}$  (Cane Sugar.)**SOLUBILITY IN WATER.**

(Herzfeld, 1892; see also Courtonne, 1877.)

t°.	Gms. $C_{12}H_{22}O_{11}$ per 100 Gms.		t°.	Gms. $C_{12}H_{22}O_{11}$ per 100 Gms.	
	Solution.	Water.		Solution.	Water.
0	64.18	179.2	40	70.42	238.1
5	64.87	184.7	45	71.32	248.7
10	65.58	190.5	50	72.25	260.4
15	66.33	197	60	74.18	287.3
20	67.09	203.9	70	76.22	320.4
25	67.89	211.4	80	78.36	362.1
30	68.70	219.5	90	80.61	415.7
35	69.55	228.4	100	82.97	487.2

Sp. Gr. of sat. solution at 15° = 1.329; at 25° = 1.340.  
100 gms. H<sub>2</sub>O dissolve 212 gms. cane sugar at 25°, determined by means of Pulfrich's refractometer. (Osaka, 1903-08.)



## SOLUBILITY OF SUGAR IN AQUEOUS SALT SOLUTIONS AT 30°, 50°, AND 70°.

Interpolated from original results.

(Schukow, 1902)

°.	Gms. Salt per 100 Gms. H <sub>2</sub> O.	Gms. C <sub>12</sub> H <sub>22</sub> O <sub>11</sub> per 100 grams H <sub>2</sub> O in Aq. Solution of:				
		KCl.	KBr.	KNO <sub>3</sub> .	NaCl.	CaCl <sub>2</sub> .
30	0	219.5	219.5	219.5	219.5	219.5
"	10	216	218	217	210	197
"	20	221	220	216	211	189
"	30	228	224	216	219	192
"	40	237	228	217	233	200
"	50	...	...	218	250	218
"	60	...	...	...	269	243
50	0	260.4	260.4	260.4	260.4	260.4
"	10	261	262	260	255	239
"	20	266	266	261	260	228
"	30	274	272	262	269	228
"	40	284	276	262	284	236
"	50	296	280	263	302	253
"	60	...	...	...	...	276
70	0	320.5	320.5	320.5	320.5	320.5
"	10	326	324	321	323	295
"	20	334	328	324	330	286
"	30	345	334	327	344	286
"	40	357	341	331	361	295
"	50	370	349	334	384	308
"	60	384	357	337	406	327

## SOLUBILITY OF CANE SUGAR IN SATURATED AQUEOUS SALT SOLUTIONS AT 31.25°. (Köhler, 1897.)

Salt.	Gms. Sugar per 100 Gms.		Salt.	Gms. Sugar per 100 Gms.	
	Solution.	Water.		Solution.	Water.
CH <sub>3</sub> COOK	...	324.8	Na <sub>2</sub> CO <sub>3</sub>	64.73	229.2
C <sub>2</sub> H <sub>5</sub> COOK	49.19	306.1	KNO <sub>3</sub>	61.36	224.7
C <sub>2</sub> H <sub>5</sub> OH.(COOK) <sub>3</sub>	50.30	303.9	K <sub>2</sub> SO <sub>4</sub>	66.74	219.0
K <sub>2</sub> CO <sub>3</sub>	56.0	265.4	CH <sub>3</sub> COOCa	60.12	190.0
KCl	62.28	246.5	Na <sub>2</sub> SO <sub>4</sub>	52.20	183.7
CH <sub>3</sub> COONa	59.93	237.6	CaCl <sub>2</sub>	42.84	135.1
NaCl	62.17	236.3	MgSO <sub>4</sub>	46.52	119.6

## SOLUBILITY OF CANE SUGAR IN AQUEOUS ALCOHOL SOLUTIONS AT 14°. (Schrefeld, 1894.)

Wt. per cent Alcohol.	Wt. per cent Sugar.	Gms. Sugar per 100 cc. Alcohol-H <sub>2</sub> O Mixture.	Wt. per cent Alcohol.	Wt. per cent Sugar.	Gms. Sugar per 100 cc. Alcohol-H <sub>2</sub> O Mixture.
0	66.2	195.8	50	38.55	62.7
5	64.25	179.7	60	26.70	36.4
10	62.20	164.5	70	12.25	13.9
20	58.55	141.2	80	4.05	4.2
30	54.05	117.8	90	0.95	0.9
40	47.75	91.	100	0.00	0.0



**SOLUBILITY OF CANE SUGAR IN AQUEOUS ALCOHOL SOLUTIONS.**  
(Scheibler, 1872; correction, 1891.)

Per cent Alcohol by Vol.	Results at 0°.			Results at 14°.				Results at 40°.
	Sp. Gr. of Solution at 17.5°.	Gms. Sugar per 100 cc. Solution.	Sp. Gr. of Solution at 17.5°.	Gms. per 100 cc. Solution.			Gms. Sugar per 100 cc. Solution.	
				Sugar.	C <sub>4</sub> H <sub>9</sub> OH.	H <sub>2</sub> O.		
0	1.325	85.8	1.326	87.5	0	45.10	...	
10	1.299	80.7	1.300	81.5	3.91	44.82	95.4	
20	1.236	74.2	1.266	74.5	8.52	43.83	90	
30	1.229	65.5	1.233	67.9	13.74	41.87	82.2	
40	1.182	56.7	1.185	58	20.24	40.38	74.9	
50	1.129	45.9	1.131	47.1	28.13	38.02	63.4	
60	1.050	32.9	1.058	33.9	37.64	34.47	49.9	
70	0.972	18.2	0.975	18.8	46.28	29.57	31.4	
80	0.893	6.4	0.895	6.6	61.15	21.95	13.3	
90	0.837	0.7	0.838	0.9	71.18	12.83	2.3	
97.4	0.806	0.08	0.808	0.36	77.39	3.28	0.5	

100 gms. absolute methyl alcohol dissolve 1.18 gms. cane sugar at 19°.  
(de Bruyn, 1892.)

**SOLUBILITY OF CANE SUGAR IN AQUEOUS ACETONE AT 25°.**  
(Herz and Knoch, 1904.)

Sp. Gr. of Solutions.	cc. Acetone per 100 cc. Solvent.	Gms. Sugar per 100 cc. Solution.	Gms. per 100 cc. Solution.		
			H <sub>2</sub> O.	(CH <sub>3</sub> ) <sub>2</sub> CO.	C <sub>2</sub> H <sub>5</sub> OH.
1.3306	0	89.8	43.3	0	89.8
1.2796	20	76.7	42.9	8.4	76.7
1.2491	30	72.1	39.5	13.4	72.1
1.2002	40	59.3	39.8	20.9	59.3
1.1613	45	52.5	39	24.6	52.5

Above 45 cc. acetone per 100 cc. solvent the solution begins to separate into two layers. The lower of these contains 51 gms. sugar per 100 cc. and has Sp. Gr. 1.1522. The upper layer contains so little sugar that the amount could not be determined by the method employed. 100 cc. evaporated in a vacuum desiccator left a residue of 3.68 gms. Above the concentration of 80 cc. acetone per 100 cc. solvent the two layers unite. In pure acetone 100 cc. solution gave a residue of 0.18 gm. sugar.

**SOLUBILITY OF SEVERAL SUGARS IN PYRIDINE AT 26°.**  
(Holty, 1905.)

Sugar.	Formula.	d <sub>20</sub> of Sat. Sol.	Gms. Sugar per 100 Gms. Sat. Sol.	
Cane Sugar (Sucrose)	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	...	6.45	
Milk Sugar (Lactose)	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub> ·H <sub>2</sub> O	0.981	2.18	
Grape Sugar (Glucose)	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> ·H <sub>2</sub> O	1.005	7.62	
Fruit Sugar (Fructose)	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	1.052	18.49+	
Galactose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	1.0065	5.45(?)	
Maltose	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	...	98.10*	(Dehn, 1917.)
Mannose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>	...	29.9*	"
Raffinose	C <sub>18</sub> H <sub>32</sub> O <sub>16</sub> ·5H <sub>2</sub> O	...	75*	"

\* It is uncertain whether these figures refer to gms. per 100 gms. sat. solution or gms. per 100 gms. pyridine at 20°-25°.

100 gms. aq. 50 per cent pyridine dissolve the following gms. of sugars at 20°-25°; sucrose, 38.5; maltose, 43.07; mannose, 78.70; lactose, 1.98; fructose, 85.42; galactose, 68.3; glucose, 49.17; raffinose, 8.76. (Dehn, 1917.)

100 gms. trichlorethylene dissolve 0.004 gm. cane sugar at 15°. (Wester & Bruins, 1914.)

For additional data on Galactose, see p. 305 and on Glucose, see p. 306.



SOLUBILITY OF MILK SUGAR (LACTOSE) HYDRATE AND  $\beta$  ANHYDRIDE IN WATER.

(Hudson, 1904, 1908.)

It was found that the saturation point was reached very slowly with this compound. From the results, it was concluded that "aqueous solutions of milk-sugar contain two substances in equilibrium and that the mutarotation of milk-sugar results from the slow establishment, in cold solutions, of the equilibrium of the balanced reaction,  $C_{12}H_{22}O_{11}$  (Hydrate)  $\rightleftharpoons H_2O + C_{12}H_{20}O_{11}$  ( $\beta$ -anhydride).

The final solubility of hydrated milk sugar was determined by approaching saturation from below and from above with mixtures of water and excess of once recrystallized hydrated milk sugar. These were constantly rotated until equilibrium was reached (one week was allowed in all cases). The filtered saturated solutions were evaporated to dryness and the crystalline residues, consisting of the  $\alpha$  and  $\beta$  anhydrides, weighed.

t°.	Gms. $C_{12}H_{22}O_{11}$ per 100 Gms. Sat. Sol.	t°.	Gms. $C_{12}H_{20}O_{11}$ per 100 Gms. Sat. Sol.
0	10.6	49	29.8
15	14.5	64	39.7
25	17.8	74	46.3
39	24	89	58.2

The initial solubility, obtained by agitating an excess of milk sugar hydrate with water for a few minutes, was somewhat less than one-half the above figures, at temperatures up to 25°.

The final solubility of  $\beta$  anhydrous milk sugar was difficult of determination on account of the high concentration and instability of the saturated solution below 92°. At 0° the final saturation was hastened by addition of 0.1  $\%$   $NH_4OH$  solution. At 0°, 42.9 gms.  $C_{12}H_{20}O_{11}$  per 100 gms. sat. solution were found and at 100°, 61.2 gms.

## SOLUBILITY OF SEVERAL SUGARS IN AQUEOUS ALCOHOL AT 20°.

(Hudson and Yanovsky, 1917.)

Sugar.	Formula.	Solvent.	Gms. Anhydrous Sugar per 100 cc. Solution.	
			Initial Solubility.	Final Solubility.
$\alpha$ Arabinose	$C_5H_{10}O_5$	80% $C_2H_5OH$	0.74	1.94
$\beta$ Cellose	$C_7H_{12}O_{11}$	20% "	3.2	4.7
$\beta$ Fructose	$C_6H_{12}O_6$	80% "	13.4	27.4
$\beta$ "	"	95% "	1.8	4.2
$\beta$ "	"	Methyl Alcohol	5.2	11.1
$\alpha$ Galactose	$C_6H_{12}O_6$	60% $C_2H_5OH$	1.1	3.1
$\alpha$ "	"	80% "	0.27	0.65
$\beta, \alpha$ Glucoheptose	$C_7H_{14}O_7$	20% "	4	4.5
$\alpha$ Glucose	$C_6H_{12}O_6$	80% "	2	4.5
$\alpha$ "	"	Methyl Alcohol	0.85	1.6
$\alpha$ " hydrate	$C_6H_{12}O_6 \cdot H_2O$	80% $C_2H_5OH$	1.3	3
$\beta$ Glucose	$C_6H_{12}O_6$	80% "	4.9	9.1
$\alpha$ Lactose hydrate	$C_{12}H_{22}O_{11} \cdot H_2O$	40% "	1.1	2.4
$\alpha$ Lyxose	$C_6H_{12}O_6$	90% "	5.4	7.9
$\beta$ Maltose hydrate	$C_{12}H_{22}O_{11} \cdot H_2O$	60% "	3	4.75
$\beta$ Mannose	$C_6H_{12}O_6$	80% "	2.4	13
$\beta$ "	"	Methyl Alcohol	0.78	4.4
$\beta$ Mellibiose Dihydrate	$C_{12}H_{22}O_{11} \cdot 2H_2O$	80% $C_2H_5OH$	0.76	1.3
$\alpha$ Rhamnose Hydrate	$C_6H_{12}O_6 \cdot H_2O$	100% "	8.6	9.5
$\alpha$ "	"	70% "	8.2	9.6
$\alpha$ Xylose	$C_5H_{10}O_5$	80% "	2.7	6.2
Sucrose	$C_{12}H_{22}O_{11}$	80% "	3.7	3.7
Trehalose Dihydrate	$C_{12}H_{22}O_{11} \cdot 2H_2O$	70% "	1.8	1.8
Raffinose Pentahydrate	$C_{18}H_{34}O_{16} \cdot 5H_2O$	50% "	1.4	1.4



## SOLUBILITY OF SORBOSE AND GULOSE IN WATER AND ALCOHOLS.

(de Bruyn and van Ekenstein, 1900.)

Sugar.	M.-pt.	Gms. Sugar per 100 cc. Sat. Sol. in:		
		H <sub>2</sub> O at 100°.	CH <sub>3</sub> OH at 17°.	C <sub>2</sub> H <sub>5</sub> OH at 17°.
d Sorbose	151	0.22	1.70	1.02
l Sorbose	150	0.23	1.68	1
l Gulose	150	0.24	1.72	1.04

100 gms. H<sub>2</sub>O dissolve 108 gms. maltose at 20°-25°.

(Dehn, 1917.)

100 gms. H<sub>2</sub>O dissolve 14.3 gms. raffinose at 20°-25°.SOLUBILITY OF PHENYLHYDRAZONES AND  $\beta$  NAPHTHYLHYDRAZONES OF THE SUGARS IN WATER AND IN ALCOHOLS AT 16°-18°.

(van Ekenstein and de Bruyn, 1896.)

The hydrazones were prepared by adding to a concentrated and warm solution of the sugar the equivalent quantity of the hydrazine dissolved in the molecular quantity of glacial acetic acid. The precipitated hydrazones were recrystallized from 30 to 50 per cent alcohol. No details in regard to the method of obtaining purification or of analysis of the solutions are given.

Phenylhydrazone of:	M.-pt.	Gms. Compound per 100 cc. Sat. Sol. in:		
		Water.	CH <sub>3</sub> OH.	C <sub>2</sub> H <sub>5</sub> OH.
Methyl Mannose	178	0.2-0.06	0.59	0.05-0.02
" Arabinose	161	"	"	"
" Rhamnose	124	"	very sl. sol.	"
" Galactose	180	"	"	"
Ethyl Galactose	169	...	...	0.1
" Mannose	159	...	...	0.2
" Arabinose	153	...	...	0.4
" Rhamnose	123	...	very sl. sol.	...
Amyl Galactose	116	...	...	0.6
" Mannose	134	...	...	3.5
" Arabinose	120	...	...	3.6
" Rhamnose	99	...	very sl. sol.	6.5
" Glucose	128	...	...	1.2
" Lactose	123	...	...	0.4
Allyl Galactose	157	...	...	0.3
" Mannose	142	...	...	0.7
" Arabinose	145	...	...	0.5
" Rhamnose	135	...	...	...
" Glucose	155	...	...	...
" Lactose	132	...	...	0.2
" Melibiose	192	...	...	0.3
Benzyl Galactose	154	...	0.9	0.08
" Mannose	165	...	0.55	0.2
" Arabinose	170	...	0.4	0.06
" Rhamnose	121	...	15.4	6.7
" Glucose	150	...	0.5	0.10
" Lactose	128	...	0.9	0.06
$\beta$ Naphthyl Galactose	167	0.14	...	0.24*
" Mannose	157	0.18	...	0.25*
" Arabinose	141	0.22	...	0.62*
" Rhamnose	170	0.20	...	0.44*
" Glucose	95	0.25	...	5*
" Xylose	70	0.32	...	6.62*
" Lactose	203	0.07	...	0.2*
" Maltose	176	...	...	0.4*
" Melibiose	135	...	...	1.3*

\* Solvent 96 per cent C<sub>2</sub>H<sub>5</sub>OH.



**SOLUBILITY OF THE BENZALIC COMPOUNDS OF SOME POLYATOMIC ALCOHOLS  
AT 16°-18°.**

(de Bruyn and van Ekenstein, 1899.)

' No details of the determinations are given. It is stated that the results are sufficiently exact for use in identifying hexites.

Name of Compound.	M.-pt.	Gms. Compd. Dissolved per 100 α. Sat. Sol. in:		
		Acetone.	Chloroform.	Alcohol.
Dibenzalerythritol	201 (Fischer)	0.34	3.64	0.02
Monobenzalarabitol	152 "	...	...	...
Dibenzaladonitol	165 "	0.64	1.36	0.14
Dibenzalxylytol	175 "	1.10	0.85	...
Dibenzalrhamnitol	203 "	0.70	2.55	1.10
Monobenzal- <i>d</i> -Sorbitol	175 (Meunier)	very easily soluble		
Dibenzal- <i>d</i> -Sorbitol	163 "	5.44	0.16	0.10
Tribenzalmannitol	213-8 (Fischer)	0.42	8.75	0.10
Tribenzal- <i>L</i> -iditol*	215-8 "	0.47	0.17	0.05
Tribenzal- <i>d</i> -talitol†	210 "	0.30	4.42	trace
Dibenzaldulcitol	215-20 "	0.42	0.83	trace
Dibenzalperseitol	230-5 "	0.04	trace	0.02

\* Prepared from *l* idonic acid. † Prepared from *d* talonic acid.

100 gms. sat. solution in pyridine contain 0.47 gm. mannitol at 26°. (Holtz, 1905.)  
100 gms. sat. solution in pyridine contain 2.5(?) gms. erythritol at 26°. "

**SULFANILIC ACID**  $\text{NH}_2\cdot\text{C}_6\text{H}_4\cdot\text{SO}_3\text{H}\cdot\text{H}_2\text{O}$ .

**SOLUBILITY IN WATER.**

(Philip, 1913; results for 60° and over by Dolinski, 1905.)

t°.	Gms. $\text{NH}_2\cdot\text{C}_6\text{H}_4\cdot\text{SO}_3\text{H}$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{NH}_2\cdot\text{C}_6\text{H}_4\cdot\text{SO}_3\text{H}$ per 100 Gms. Sat. Sol.	Solid Phase.
0	0.444	$\text{NH}_2\cdot\text{C}_6\text{H}_4\cdot\text{SO}_3\text{H}\cdot\text{H}_2\text{O}$	44	2.44	$\text{NH}_2\cdot\text{C}_6\text{H}_4\cdot\text{SO}_3\text{H}\cdot\text{H}_2\text{O}$
7.2	0.622	"	44	2.36	$\text{NH}_2\cdot\text{C}_6\text{H}_4\cdot\text{SO}_3\text{H}$
13.3	0.841	"	47.5	2.52	"
18.9	1.093	"	54.5	2.85	"
18.9	1.137	$\text{NH}_2\cdot\text{C}_6\text{H}_4\cdot\text{SO}_3\text{H}\cdot\text{H}_2\text{O}$	60	3.01	"
25.1	1.384	"	70	3.65	"
31.1	1.662	"	80	4.32	"
37.2	2.004	"	100	6.26	"

**SULFONIUM PERCHLORATES**

**SOLUBILITY IN WATER.**

(Hofmann, Höbold and Quoos, 1911-12.)

Name.	Formula.	t°.	Per 100 Gms. $\text{H}_2\text{O}$ .	
			Gm. Mols.	= Gms.
Trimethyl Sulfine Perchlorate	$(\text{CH}_3)_3\text{SClO}_4$	16.5	0.0784	13.84
Ethyl dimethyl "	$\text{C}_2\text{H}_5(\text{CH}_3)_2\text{SClO}_4$	15.9	0.1191	22.31
Propyl " "	$\text{C}_3\text{H}_7(\text{CH}_3)_2\text{SClO}_4$	15	0.0590	12.04
<i>n</i> Butyl " "	$\text{C}_4\text{H}_9(\text{CH}_3)_2\text{SClO}_4$	15	0.0607	13.24
Ethylene dimethyl "	$\text{C}_2\text{H}_4(\text{C}_2\text{H}_5\text{SClO}_4)_2$	18	0.0423	14.86
Vinyl dimethyl "	$\text{C}_2\text{H}_3\text{S}(\text{CH}_3)_2\text{ClO}_4$	18	0.0731	13.75
Trimethylene dimethyl "	$\text{C}_3\text{H}_4(\text{C}_2\text{H}_5\text{SClO}_4)_2$	18	0.0402	14.68



TriethylSULFONIUM IODIDE  $S(C_2H_5)_3I$ .100 gms.  $H_2O$  dissolve 431 gms.  $S(C_2H_5)_3I$  at  $25^\circ$ .

(Peddle and Turner, 1913.)

100 gms.  $CHCl_3$  dissolve 47.7 gms.  $S(C_2H_5)_3I$  at  $25^\circ$ .

(Peddle and Turner, 1913.)

SULFUR  $S$ .

In a series of papers by Aten (1905-06, 1912, 1912-13, 1913, 1914 and 1914a), the preparation and properties of the four known modifications of sulfur are described. These are designated by the symbols,  $S_A$ ,  $S_M$ ,  $S_r$  and  $S_p$ .

$S_A$  is ordinary rhombic sulfur and its molecule is considered to be composed of eight atoms of sulfur,  $S_8$ .

$S_M$  is the insoluble, so-called amorphous sulfur.

$S_r$  is obtained when ordinary sulfur is heated above its melting-point and quickly cooled; it is especially easily prepared by warming  $S_A$  in sulfur chloride. Its molecule is probably represented by  $S_4$ .

$S_p$  was discovered by Engel and is prepared by mixing concentrated  $HCl$ , cooled to  $0^\circ$ , with saturated sodium thiosulfate solution. The precipitated  $NaCl$  is removed by filtration and the solution extracted with toluene. The aqueous layer soon yields a cloudy precipitate of  $S_p$ . The molecule of this sulfur is considered to have the composition  $S_4$ .

SOLUBILITY OF SULFUR ( $S_A$ ) IN SULFUR MONOCHLORIDE ( $S_2Cl_2$ ) DETERMINED BY THE MELTING-POINT METHOD.

(Aten, 1905-06.)

$t^\circ$ of Melting.	Mol. % $S_2$ in Mixture.	Solid Phase.	$t^\circ$ of Melting.	Mol. % $S_2$ in Mixture.	Solid Phase.
-16	4.3	Rhombic S	83.5	67	Rhombic S
0	6	"	95.6	81.8	"
+17.9	9.9	"	86	81.8	Monoclinic S
36.8	17.1	"	103.2	88.4	"
55.2	28.5	"	110.4	95	"
65.6	40.3	"	118.8	100	"
77.7	55.4	"			

SOLUBILITY OF SULFUR ( $S_r$ ) IN SULFUR MONOCHLORIDE ( $S_2Cl_2$ )

(Aten, 1912-13.)

A preliminary experiment showed that if a solution of  $S_A$  in sulfur monochloride, saturated at  $20^\circ$ , is heated to  $170^\circ$  and cooled, it will then dissolve as much  $S_A$  as already required to saturate it. The following determinations were made by sealing known amounts of  $S_A$  and  $S_2Cl_2$  in tubes, heating them to  $100^\circ$  for several hours and then cooling quickly to the indicated temperatures and shaking for  $\frac{1}{2}$  hour in the case of the  $0^\circ$  and  $25^\circ$  results and 2 hours in the case of the  $-60^\circ$  results. The saturated solutions were analyzed by oxidizing with  $HCl + HNO_3 + Br$  and titrating the  $H_2SO_4$ , after removing the volatile acids.

Atoms S per 100 Atoms S + $S_2Cl_2$ in:				Atoms S per 100 Atoms S + $S_2Cl_2$ in:			
Original Mixture.	Saturated Solution at:			Original Mixture.	Saturated Solution at:		
	$-60^\circ$ .	$0^\circ$ .	$+25^\circ$ .		$-60^\circ$ .	$0^\circ$ .	$+25^\circ$ .
0	11.6	36.1	53.5	79.4	65.2	72	...
10	18.1	40.1	57.6	80.1	66.1	71.6	...
28.7	31.9	47.4	62	89.9	...	...	82.1
49.9	42.9	56	66.4	90.1	...	80.5	...
60.1	47.7	59.9	66.4	94.6	...	...	87.7
69.1	...	...	72.8	98	...	...	93.4

Results similar to the above are also given (Aten, 1912), for mixtures previously heated to  $50^\circ$ ,  $75^\circ$  and  $125^\circ$ . All the data confirm the formation of the the new modification  $S_r$ .



SOLUBILITY OF SULFUR ( $S_8$ ) IN SULFUR MONOCHLORIDE ( $S_2Cl_2$ ) AT 25°.  
(Aten, 1912, 1913.)

The samples were heated to the temperatures indicated and rapidly cooled and powdered. The method of determining the solubilities is not described.

Previous Treatment of Sample.	Atoms S Dis- solved per 100 Atoms $S_2Cl_2$ .
Unheated Sulfur	53.5
Mixture of Rhombic and Amorphous Sulfur	54.5
Rhombic Sulfur heated to 125°	56-58.5 (depending on excess of S present.)
" " " " 165°	60 (determined immediately.)
" " " " 165°	59.5 " after 1 hr.)
" " " " 165°	57.5 " " 24 hrs.)
" " " " 165°	53.2 " " 8 days.)

SOLUBILITY OF SULFUR ( $S_8$ ) IN TOLUENE AT 0° AND AT 25°.  
(Aten, 1913.)

Comp. of Mix- ture in Atom Per cent S.	Solubility in Atom % S.		Comp. of Mix- ture in Atom Per cent S.	Solubility in Atom % S.	
	At 0°.	At 25°.		At 0°.	At 25°.
35	2.88	5.94	74	4.05	7.52
47	...	6.65	77	3.90	...
54	3.26	6.76	80	4.22	...
57	3.30	6.88	83	...	7.93
73	...	7.45	85	...	8.08

These results show that the greater the excess of  $S_8$ , the greater the solubility. It was found that under the same conditions, unchanged rhombic sulfur gives constant figures irrespective of the excess of S present. At 0°, 2.59 atom per cent  $S_8$  was found and at 25°, 5.65 atom per cent.

SOLUBILITY OF SULFUR ( $S_8$ ) IN CARBON DISULFIDE AND CARBON  
TETRACHLORIDE.  
(Wigand, 1910.)

When "insoluble" sulfur ( $S_8$ ) is treated with  $CS_2$  or  $CCl_4$ , a small amount dissolves, depending upon the length of time of contact, temperature and nature of the solvent but not on the relative amount of solvent. This action is explained on the assumption that a partial transformation of  $S_8$  to soluble sulfur  $S_2$ , takes place.

Data for the fusion points of mixtures of rhombic sulfur and "insoluble" sulfur ( $S_8$ ) and for monoclinic sulfur and "insoluble" sulfur ( $S_8$ ) are given by Kruyt (1908).

SOLUBILITY OF SULFUR IN LIQUID AMMONIA.  
(Ruff and Hecht, 1911.)

At the temperatures 0° to 40°, the solutions were constantly shaken for 3 to 4 days. For the results at the lower temperatures the solutions were saturated at room temperature then cooled, partially evaporated and shaken 4 to 6 hours. The saturated solutions were analyzed by evaporation of the ammonia by means of a current of hydrogen, absorbing in HCl and converting to the platinic chloride for weighing. The S residues were dried at 100°, with proper precautions, and weighed.

t°.	Gms. S per 100 Gms. Sat. Solution.	t°.	Gms. S per 100 Gms. Sat. Solution.
-78	38.6*	+16.4	25.65
-20.5	38.1*	30	21
0	32.34	40	18.5

\* This figure corresponds to the compound  $S(NH_3)_2 = 38.5\%$  S.



## SOLUBILITY OF SULFUR IN AQUEOUS SODIUM SULFIDE SOLUTIONS.

(Küster and Heberlein, 1905.)

The results are expressed in terms of  $x$  which represents the number of S atoms dissolved for each  $\text{Na}_2\text{S}$  in the solution. The figures, therefore, show the atomic ratio of S to  $\text{Na}_2\text{S}$  in the saturated solution and at the same time, the sulfur content of the compound  $\text{Na}_2\text{S}_x$  which is formed. In order to find the actual amount of sulfur dissolved per liter, it is only necessary to multiply the  $x$  value by the normality of the aqueous sodium sulfide solution used as solvent in the particular case.

A series of determinations made at  $25^\circ$ , by agitating aqueous sodium sulfide solutions with crystalline sulfur until equilibrium was reached, and then diluting each solution with an equal volume of water and shaking with excess of sulfur until equilibrium was again reached, gave the following results:

Normality of the Aq. $\text{Na}_2\text{S}$ Solution.	$x$ in the Resulting $\text{Na}_2\text{S}_x$ .	Normality of the Aq. $\text{Na}_2\text{S}$ Solution.	$x$ in the Resulting $\text{Na}_2\text{S}_x$ .
4	4.475	0.125 (32 hrs.)	5.225
2 (2 hrs.)	4.666	0.0625	5.239
1	4.845	0.03125	5.198
0.5	4.984	0.015625	5.034
0.25	5.115	0.007812 (128 hrs.)	4.456

The figures in parentheses in the above table show the number of hours required for attainment of equilibrium in these three cases. The authors also made determinations of the influence of temperature on the amount of sulfur dissolved, and found that for a normal  $\text{Na}_2\text{S}$  solution, the  $x$  value did not vary appreciably from the figure given above, over the range  $0^\circ$  to  $50^\circ$ .

Results are also given showing the influence of the presence of  $\text{NaCl}$  and of  $\text{OH}$  on the amount of sulfur dissolved by aqueous  $\text{Na}_2\text{S}$  solutions. In the former case the solubility was distinctly lowered, while in the latter it was notably increased.

## SOLUBILITY OF SULFUR IN:

## Tin Tetrachloride.

(Gerardin, 1865.)

$t^\circ$ .	Gms. S per 100 Gms. $\text{SnCl}_4$ .	Solid Phase.
99	5.8	Solid S
101	6.2	"
110	8.7-9.1	"
112	9.4-9.9	Liquid S
121	17.0	"

## Amyl Alcohol.

(Gerardin.)

$t^\circ$ .	Gms. S per 100 Gms. $\text{C}_5\text{H}_{11}\text{OH}$ .	Solid Phase.
95	1.5	Solid S
110	2.1-2.2	"
112	2.6-2.7	Liquid S
120	3.0	"
131	5.3	"

SOLUBILITY OF SULFUR IN AQUEOUS ACETONE AT  $25^\circ$ .

(Hers and Knoch, 1905.)

Wt. Per cent Acetone in Solvent.	Sulfur per 100 cc. Solution.		Sp. Gr. of Solution.
	Millimols.	Gms.	
100	65	2.084	0.7854
95.36	45	1.442	0.7911
90.62	33	1.058	0.8165
85.38	25.3	0.811	0.8295



## SOLUBILITY OF SULFUR IN ETHYL AND METHYL ALCOHOLS.

t°.	Alcohol.	Gms. per 100 Gms. Alcohol.	Authority.
15	Abs. Ethyl	0.051	(Pohl.)
18.5	"	0.053	(de Bruyn — Z. physik. Chem. 10, 781, '90)
b. pt.	"	0.42	(Payen — Compt. rend. 34, 356, '52.)
18.5	Abs. Methyl	0.028	(de Bruyn.)

SOLUBILITY OF SULFUR IN BENZENE AND IN ETHYLENE DIBROMIDE.  
(Etard, 1894; see also Cossa, 1868.)

In $C_6H_6$ .				In $C_2H_4Br_2$ .			
t°.	Gms. S per 100 Gms. Solution.	t°.	Gms. S per 100 Gms. Solution.	t°.	Gms. S per 100 Gms. Solution.	t°.	Gms. S per 100 Gms. Solution.
0	1.0	70	8.0	0	1.2	50	6.4
10	1.3	80	10.5	10	1.7	60	8.4
20	1.7	90	13.8	20	2.3	70	11.4
25	2.1	100	17.5	25	2.8	80	16.5
30	2.4	110	23.0	30	3.3	90	24.0
40	3.2	120	29.0	40	4.4	100	36.5
50	4.3	130	36.0				
60	6.0						

RECIPROCAL SOLUBILITY OF SULFUR AND BENZENE, DETERMINED BY THE  
SYNTHETIC METHOD.  
(Kruyt, 1908-09.)

Wt. % S in Mixture.	Limiting t° of Homogeneity.		Wt. % S in Mixture.	Limiting t° of Homogeneity.	
	Lower.	Upper.		Lower.	Upper.
41.5	146	247	79.8	141	230
55.2	158	230	81.4	138	above 246
74.5	157	226	83.4	131	" 272

100 gms. sat. solution of S in benzoyl chloride,  $C_6H_5.COCl$ , contain 1 gm. S at 0° and 55.8 gms. at 134°.  
(Bogousky, 1905.)

SOLUBILITY OF OCTOEDRAL AND OF PRISMATIC SULFUR IN SEVERAL SOLVENTS.  
(Brönsted, 1906.)

The solubility of prismatic sulfur could not be determined in the ordinary way on account of its rapid transition to octohedral sulfur. A special apparatus was used which permitted the solvent to remain in contact with the solid for only a short time. Since sulfur dissolves very rapidly, this procedure was found to give satisfactory results.

Solvent.	t°.	Gms. each Variety Separately per 100 cc. Saturated Solution.	
		Prismatic Sulfur.	Octohedral Sulfur.
Benzene	18.6	2.004	1.512
"	25.3	2.335	1.835
Chloroform	0	1.101	0.788
"	15.5	1.658	1.253
"	40	2.9	2.4
Ethyl Ether	0	0.113	0.080
"	25.3	0.253	0.200
Ethyl Bromide	0	0.852	0.611
"	25.3	1.676	1.307
Ethyl Formate	0	0.028	0.019
Ethyl Alcohol	25.3	0.066	0.052



## SOLUBILITY OF SULFUR IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. S per 100 Gms. Solvent.	Solvent.	t°.	Gms. S per 100 Gms. Solvent.
Aniline	130	85.3 (1)	Glycerol	15.5	0.14 (4)
Benzene	15.2	1.5 (2)	Hydrazine (anhy.)	room temp.	54 (decomp.) (5)
"	19.3	1.7 (2)	Lanoline (anhy.)	45	0.38 (6)
"	26	0.97 (1)	Methylene Iodide	10	10 (7)
"	71	4.38 (1)	Nicotine	100	10.6 (8)
Carbon Tetrachloride	25	0.86 (3)	Phenol	174	16.4 (1)
Chloroform	12.2	0.75 (2)	Pentachlor Ethane	25	1.2 (3)
"	19.3	0.92 (2)	Toluene	23	1.48 (1)
"	22	1.21 (1)	Tetrachlor Ethane	25	1.23 (3)
Dichlor Ethylene	25	1.28 (3)	Tetrachlor Ethylene	25	1.53 (3)
Ethylene Chloride	25	0.84 (3)	Trichlor Ethylene	25	1.63 (3)
Ethyl Ether	23.5	0.97 (1)	"	15	1.16 (9)

(1) Cossa, 1868; (2) Brønsted, 1906; (3) Hoffman, Kirmreuther and Thal, 1910; (4) Ossendowski, 1907; (5) Welsh and Broderson, 1915; (6) Klose, 1907; (7) Retgers, 1893; (8) Kleven, 1872; (9) Wester and Krums, 1914.

## SOLUBILITY OF SULFUR IN CARBON DISULFIDE.

(Etard, 1894; Cossa, 1865; at 10°, Retgers, 1893; below 77°, Arctowski, 1895-96.)

t°.	Gms. S per 100 Gms. Solution.	CS <sub>2</sub>	t°.	Gms. S per 100 Gms. Solution.	CS <sub>2</sub>	t°.	Gms. S per 100 Gms. Solution.	CS <sub>2</sub>
-110	3.0	3.1	-10	13.5	15.6	50	59.0	143.9
-100	3.5	3.6	0	18.0	22.0	60	66.0	194.1
-80	4.0	4.2	10	23.0*	29.9	70	72.0	257.1
-60	3.5	3.6	20	29.5	41.8	80	79.0	376.1
-40	6.0	6.4	25	33.5	50.4	90	86.0	614.1
-20	10.5	11.7	30	38.0	61.3	100	92.0	1150.0
			40	50.0	100.0			

\* 26.4 R.

Sp. Gr. of solution saturated at 15° containing 26 gms. S per 100 gms. solution = 1.372.

SOLUBILITY OF SULFUR IN HEXANE (C<sub>6</sub>H<sub>14</sub>).

(Etard.)

t°.	Gms. S per 100 Gms. Solution.	t°.	Gms. S per 100 Gms. Solution.	t°.	Gms. S per 100 Gms. Solution.
-20	0.07	60	1.0	130	5.2
0	0.16	80	1.7	140	6.0
20	0.25	100	2.8	160	7.2
40	0.55	120	4.4	180	8.2

SOLUBILITY OF SULFUR (S<sub>8</sub>) IN  $\beta$  NAPHTHOL, DETERMINED BY THE SYNTHETIC METHOD.

(Smith, Holmes and Hall, 1905.)

The mixtures of sulfur and  $\beta$  naphthol were heated until they were homogeneous and then cooled to the temperature at which clouding appeared.

t° of Clouding.	Gms. S per 100 Gms. $\beta$ Naphthol.	t° of Clouding.	Gms. S per 100 Gms. $\beta$ Naphthol.	t° of Clouding.	Gms. S per 100 Gms. $\beta$ Naphthol.
118	34	154	84.1	164	209.7
132.5	46.6	157	97.4	163.8	238.1
134.5	48.8	160.5	119.3	163.8	264.8*
143.5	59.3	162.5	145.1	163	300 *
149.5	70	163.5	177.6		

\* Solid phase,  $\beta$  naphthol.



## SULFUR

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SOLUBILITY OF SULFUR IN COAL TAR OIL, LINSEED OIL AND IN OLIVE OIL.  
(Pelouse, 1869; Pohl.)

g°. Sp. Gr.: b. pt.:	Grams S per 100 Grams Coal Tar Oil of:						G. S per 100 Gms.	
	0.87 80°-100°.	0.88 85°-120°.	0.882 120°-220°.	0.885 150°-200°.	1.01 210°-300°.	1.02 220°-300°.	Linseed Oil.	Olive Oil of 0.885 Sp. Gr.
15	2.1	2.3	2.5	2.6	6.0	7.0	0.4	2.3
30	3.0	4.0	5.3	5.8	8.5	8.5	0.6	4.3
50	5.2	6.1	8.3	8.7	10.0	12.0	1.2	9.0
80	11.8	13.7	15.2	21.0	37.0	41.0	2.2	18.0
100	15.2	18.7	23.0	26.4	52.5	54.0	3.0	25.0
110	...	23.0	26.2	31.0	105.0	115.0	3.5	30.0
120	...	27.0	32.0	38.0	∞	∞	4.2	37.0
130	...	...	38.7	43.8	∞	∞	5.0	43.0

(160°) 10.0

100 gms. oil of turpentine dissolve 1.35 gms. S at 16°, and 16.2 gms. at b. pt.  
(Payen, 1851.)SOLUBILITY OF SULFUR IN TRIPHENYL METHANE, DETERMINED BY THE  
SYNTHETIC METHOD.

Results of Smith, Holmes & Hall, 1905.				Results of Kruyt, 1908-09.			
% Triphenyl Methane in Mixture.	t° of First Limit of Mixing.	% Triphenyl Methane in Mixture.	t° of Second Limit of Mixing.	% Triphenyl Methane in Mixture.	t° of First Limit of Mixing.	% Triphenyl Methane in Mixture.	t° of Second Limit of Mixing.
69.1	108.5	35.5	214.5	66.7	113	7	211.5
58.8	127	32.5	211	60.2	125.3	9.3	201.5
50.8	136.5	28.4	206	50.2	136.8	12	198.8
46.6	141	24.5	203	41	144.2	13.7	199.5
42.8	144	21.6	200	30.8	146	16.4	200.4
37.8	146	19.2	199	20	145.2	19.8	202.1
33.7	146.5	15.4	198	13.2	137.6	23.5	203.7
30.3	147			8.1	118.6	28.7	208
25.4	146			7	crystals	34.5	215.2

SOLUBILITY OF SULFUR IN PHENOL, DETERMINED BY THE SYNTHETIC METHOD.  
(Smith, Holmes and Hall, 1905.)

The mixtures of sulfur and phenol were heated until they were homogeneous and then cooled to the temperature at which clouding appeared.

t° of Clouding.	Gms. S per 100 Gms. Phenol.	t° of Clouding.	Gms. S per 100 Gms. Phenol.	t° of Clouding.	Gms. S per 100 Gms. Phenol.
89.5	9.1	155	26.3	166	31.6
96.5	10.4	157.5	27.1	167.5	32.4
122.5	15.3	160.5	28.6	170	33.5
138	19.9	162	29.6	172	34.9
148.5	23.6	164.5	30.7	175	36.5

RECIPROCAL SOLUBILITY OF SULFUR AND TOLUENE, DETERMINED BY THE  
SYNTHETIC METHOD.  
(Kruyt, 1908-09.)

Wt. % S in Mixture.	Limiting t° of Homogeneity.		Wt. % S in Mixture.	Limiting t° of Homogeneity.	
	Lower.	Upper.		Lower.	Upper.
50.5	167	250	75.7	178	221
62	179	223	77.9	174	...
69.6	180	222	83.3	160	223
73	180	222	90.5	124	above 250



### RECIPROCAL SOLUBILITY OF SULFUR AND META XYLENE, DETERMINED BY THE SYNTHETIC METHOD.

(Kruyt, 1908-09.)

Wt. % S in Mixture.	Limiting $t^\circ$ of Homogeneity.		Wt. % S in Mixture.	Limiting $t^\circ$ of Homogeneity.	
	Lower.	Upper.		Lower.	Upper.
50.9	181	213	39.9	152	none (230)
49.1	177	228	84.2	none	"
47.7	172.5	none (?)	86.1	164.5	199
44.2	161.5	" (255)	87	159	202.5
40.4	153.5	" (215)	90	139	none (220)

Fusion-point data for the system sulfur-tellurium are given by Pelabon (1909); Pellini (1909); Chikashige (1911, 1911-12); Jaeger and Menke (1912).

Data for mixtures of sulfur and each of the following metals are given by Pelabon (1909); antimony, tin, lead, silver, gold and arsenic.

### SULFUR DIOXIDE $\text{SO}_2$

#### SOLUBILITY IN WATER.

(Schönfeld, 1855; Sims, 1861; Roozeboom, 1884.)

Schönfeld.				Sims.			Roozeboom.	
$t^\circ$ .	Vols. $\text{SO}_2$ (at $0^\circ$ and 760 mm.) per 1 Vol.		Gms. $\text{SO}_2$ per 100 Gms. $\text{H}_2\text{O}$ at total pressure 760 mm.	$t^\circ$ .	$\text{SO}_2$ per 1 Gm. $\text{H}_2\text{O}$ .		$t^\circ$ .	$\text{SO}_2$ Dissolved per 1 pt. $\text{H}_2\text{O}$ at 760 mm. pressure.
	Sat. $\text{SO}_2$ + Aq.	$\text{H}_2\text{O}$ .			Gms.	Vols.		
0	68.86	79.79	22.83	8	0.168	58.7	0	0.236
5	59.82	67.48	19.31	10	0.154	53.9	2	0.218
10	51.38	56.65	16.21	14	0.130	45.6	4	0.201
15	43.56	47.28	13.54	20	0.104	36.4	6	0.184
20	36.21	39.37	11.29	26	0.087	30.5	7	0.176
25	30.77	32.79	9.41	30	0.078	27.3	8	0.168
30	25.82	27.16	7.81	36	0.065	22.8	10	0.154
35	21.23	22.49	...	40	0.058	20.4		
40	17.01	18.77	5.41	46	0.050	17.4	12	0.142
				50	0.045	15.6		

Sp. Gr. of sat. solution at  $0^\circ$  = 1.061; at  $10^\circ$ , 1.055; at  $20^\circ$  = 1.024.

The results of Sims are discussed and recalculated by Fulda, 1909.

1 gm.  $\text{H}_2\text{O}$  dissolves 0.0909 gm.  $\text{SO}_2$  = 34.73 cc. (measured at  $25^\circ$ ) at  $25^\circ$  and 760 mm. pressure.

(Walden and Centnerszwer, 1902-03.)

#### FREEZING-POINT DATA FOR THE SYSTEM SULFUR DIOXIDE — WATER.

(Baume and Tykociner, 1914.)

$t^\circ$ of Freezing.	Mols. $\text{SO}_2$ per 100 Mols. $\text{SO}_2 + \text{H}_2\text{O}$ .	Solid Phase.	$t^\circ$ of Freezing.	Mols. $\text{SO}_2$ per 100 Mols. $\text{SO}_2 + \text{H}_2\text{O}$ .	Solid Phase.
0	0	Ice	7.7	5.1	$\text{SO}_2$ Hydrate
-0.2	0.8	"	8.3	5.9	"
-3 Eutec.	...	" + $\text{SO}_2$ Hydrate	9.3	7.1	"
-0.2	2.8	$\text{SO}_2$ Hydrate	12.1	11	"
+3.5	3.3	"	:	:	:
6.8	5.5	"	12.2	95.1	"

At the temperature  $+12.1^\circ$  and extending over the range of concentration 11 to 95.1 mols. per cent  $\text{SO}_2$  a second phase rich in  $\text{SO}_2$  separates. This crystallizes at  $-74^\circ$  and the diagram is consequently composed of two lines parallel to the axis of concentration, the one at the  $+12.1^\circ$  level corresponding to the  $\text{SO}_2$  hydrate, and the other at the  $-74^\circ$  level, to the  $\text{SO}_2$  rich phase. The diagram is terminated by a very short branch rising from  $-74^\circ$  to the temperature of solidification of pure  $\text{SO}_2$  ( $-72.3^\circ$ ).



SOLUBILITY OF SULFUR DIOXIDE IN WATER AT DIFFERENT PRESSURES  
(Lindner, 1912.)

Results at 0°.		Results at 25°.		Results at 50°.	
Pressure in mm. Hg.	Gms. SO <sub>2</sub> per 100 cc. Sat. Sol.	Pressure in mm. Hg.	Gms. SO <sub>2</sub> per 100 cc. Sat. Sol.	Pressure in mm. Hg.	Gms. per 100 Sat. Sol.
0.4	0.0537	1.4	0.0534	4.9	0.05
3.5	0.237	11.75	0.234	30.5	0.22
29.4	1.227	87.9	1.212	204.5	1.18
109.4	3.804	313	3.750	696	3.62

SOLUBILITY OF SULFUR DIOXIDE IN AQUEOUS SALT SOLUTIONS.  
(Fox, 1902.)

Results in terms of the Ostwald Solubility Expression. See p. 227.

Aqueous Salt Solution.	Solubility Coefficient $l$ of SO <sub>2</sub> in aq. Solutions of Concentrations:					
	0.5 Normal	1.0 N.	1.5 N.	2.0 N.	2.5 N.	3.0 N.
NH <sub>4</sub> Cl	$l_{25} = 34.58$	36.37	38.06	39.76	41.37	42.78
NH <sub>4</sub> Br	$l_{25} = 36.25$	39.46	42.78	46.06	49.17	52.25
NH <sub>4</sub> CNS	$l_{25} = 37.78$	42.74	47.26	52.26	57.01	61.46
NH <sub>4</sub> NO <sub>3</sub>	$l_{25} = 33.96$	35.07	36.28	37.27	38.01	39.14
NH <sub>4</sub> NO <sub>2</sub>	$l_{25} = 23.35$	24.23	24.78	25.57	26.66	27.43
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	$l_{25} = 33.35$	33.82	34.33	34.95	35.47	35.96
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>	$l_{25} = 22.91$	23.14	23.49	23.93	24.23	24.60
CdCl <sub>2</sub>	$l_{25} = 31.66$	30.55	29.46	28.16	27.09	26.06
CdCl <sub>2</sub>	$l_{25} = 21.73$	21.23	20.55	20.02	19.23	18.68
CdBr <sub>2</sub>	$l_{25} = 31.91$	31.01	30.17	29.27	28.15	27.46
CdBr <sub>2</sub>	$l_{25} = 21.88$	21.46	20.81	20.60	19.70	19.17
CdI <sub>2</sub>	$l_{25} = 33.27$	33.76	34.16	34.74	34.98	35.77
CdI <sub>2</sub>	$l_{25} = 22.75$	23.06	23.36	23.71	23.99	24.30
CdSO <sub>4</sub>	$l_{25} = 31.11$	29.71	28.24	26.58	25.14	23.76
CdSO <sub>4</sub>	$l_{25} = 21.45$	20.43	19.42	18.31	17.42	16.25
KCl	$l_{25} = 34.42$	36.05	37.76	39.32	40.96	42.27
KCl	$l_{25} = 23.74$	25.15	26.54	27.94	28.93	30.02
KBr	$l_{25} = 35.94$	39.11	42.41	44.96	48.87	52.26
KBr	$l_{25} = 24.83$	27.49	29.64	31.93	34.12	36.14
KCNS	$l_{25} = 37.57$	42.38	47.02	51.81	55.87	61.26
KCNS	$l_{25} = 25.63$	28.79	32.03	35.05	38.13	42.94
KI	$l_{25} = 38.66$	44.76	50.58	56.75	62.63	68.36
KI	$l_{25} = 26.30$	30.25	34.64	38.04	41.87	45.43
KNO <sub>3</sub>	$l_{25} = 33.80$	34.79	35.77	36.66	37.57	38.52
KNO <sub>3</sub>	$l_{25} = 23.27$	24.03	24.79	25.72	26.54	27.33
K <sub>2</sub> SO <sub>4</sub>	$l_{25} = 33.20$	33.61	...	...	...	...
NaBr	$l_{25} = 33.76$	34.54	35.27	36.26	36.84	37.74
NaCl	$l_{25} = 32.46$	32.25	31.96	31.76	31.51	31.36
NaCNS	$l_{25} = 35.44$	38.24	40.78	43.37	45.86	48.34
Na <sub>2</sub> SO <sub>4</sub>	$l_{25} = 31.96$	31.14	30.45	29.51	28.66	28.44
Na <sub>2</sub> SO <sub>4</sub>	$l_{25} = 21.88$	21.35	20.81	20.21	19.75	19.27

The author also gives a series of determinations in which a mixture of SO<sub>2</sub> + CO<sub>2</sub> is used for saturating the solutions, thus changing the concentration of the SO<sub>2</sub> and yielding results for certain partial pressures of this gas.

Additional data for the solubility of sulfur dioxide in aqueous salt solutions are given by Walden and Centnerszwer (1902-03) but these authors present their results in terms of the difference between the amount of SO<sub>2</sub> dissolved in water and in the aqueous solution. The exact manner in which these calculations were made is not clearly explained.



## SOLUBILITY OF SULFUR DIOXIDE IN SULFURIC ACID OF 1.84 SP. GR.

Extrapolated from original results.

(Dunn, 1882.)

t°.	Sp. Gr. of Sat. Solution.	Coefficient of Absorption (760 mm.).	t°.	Sp. Gr. of Sat. Solution.	Coefficient of Absorption (760 mm.)
0	...	53.0	50	1.8186	9.5
10	1.8232	35.0	60	1.8165	7.0
20	1.8225	25.0	70	1.8140	5.5
25	1.8221	21.0	80	1.8112	4.5
30	1.8216	18.0	90	1.8080	4.0
40	1.8205	13.0			

## SOLUBILITY OF SULFUR DIOXIDE IN AQUEOUS SULFURIC ACID SOLUTIONS.

(Dunn; see also Kolb, 1872.)

Sp. Gr. of H <sub>2</sub> SO <sub>4</sub> Solution.	Approximate Per cent H <sub>2</sub> SO <sub>4</sub> .	Coefficient of Absorption.	t°.	Sp. Gr. of H <sub>2</sub> SO <sub>4</sub> Solution.	Approximate per cent H <sub>2</sub> SO <sub>4</sub> .	Coefficient of Absorption
1.139	20	48.67	15.2	1.173	25	31.82
1.300	40	45.38	16.8	1.151	21	31.56
1.482	58	39.91	14.8	1.277	36	30.41
1.703	78	29.03	15.1	1.458	56	29.87
1.067	10	36.78	15.6	1.609	70	25.17
1.102	15	3.408	15.0	1.739	81	20.83

definition of Coefficient of Absorption, see Ethane p. 285.

## SOLUBILITY OF SULFUR DIOXIDE IN ALCOHOLS AND IN OTHER SOLVENTS.

(de Bruyn, 1892; Schulze, 1881.)

n Ethyl Alcohol at 760 mm.		In Methyl Alcohol at 760 mm.		In Several Solvents at 0° and 725 mm. (S.)	
Gms. SO <sub>2</sub> per 100 Gms. Solution.	C <sub>2</sub> H <sub>5</sub> OH.	Gms. SO <sub>2</sub> per 100 Gms. Solution.	CH <sub>3</sub> OH.	Solvent.	SO <sub>2</sub> per 1 Gm. Solvent.
					Grams. Vols.
53.5	115.0	71.1	246.0	Camphor	0.880 308
45.0	81.0	59.9	149.4	CH <sub>3</sub> COOH	0.961 318
39.9	66.4	52.2	109.2	HCOOH	0.821 351
32.8	48.8	(17.8°) 44.0	78.6	(CH <sub>3</sub> ) <sub>2</sub> CO	2.07 589
24.4	32.3	31.7	46.4	SO <sub>2</sub> Cl <sub>2</sub>	0.323 189

## SOLUBILITY OF SULFUR DIOXIDE IN CHLOROFORM.

(Lindner, 1912.)

Results at 0°.

Results at 25°.

Pressure in mm. Hg.	Gms. SO <sub>2</sub> per 100 cc Sat. Sol.	Pressure in mm. Hg.	Gms. SO <sub>2</sub> per 100 cc Sat. Sol.
2.7	0.0701	5.7	0.0669
5.6	0.1790	12.9	0.1712
22	0.6982	48	0.6728
90.2	3.097	200.2	2.954
219.6	8.217	488.8	7.839



SOLUBILITY OF SULFUR DIOXIDE IN SEVERAL SOLVENTS.  
(Lloyd, 1918.)

The dry, air free,  $\text{SO}_2$  was passed through the solvent until saturation was reached and 5 cc. (usually) of the saturated solution were mixed with a large volume of water and titrated with standardized iodine solution.

t°.	Gms. $\text{SO}_2$ per Liter of Saturated Solution in:				
	Benzene.	Nitro- benzene.	Toluene.	o Nitro- toluene.	Acetic Anhydride.
- 5	...	...	...	...	196
0	...	...	...	...	148 ( $d = 1.32$ )
+ 5	...	...	...	...	136
10	...	...	...	...	122
15	...	311.4	...	290.8	114
20	...	267.4	217.5	236	106
25	...	227.9	170.4	192.2	99
30	127.5	190	124.4	160.7	90
40	82.9	132	93.6	118.5	...
50	60.3	98.7	77.2	87.2	...
60	34	78.6	54.7	68.8	...

DISTRIBUTION OF SULPHUR DIOXIDE AT 20° BETWEEN:  
(McCrae and Wilson, 1903.)

Water and Chloroform.					Aq. HCl and Chloroform.				
Gms. $\text{SO}_2$ per Liter in:		Gm. Equiv. $\frac{1}{2}\text{SO}_2$ per Liter in:		Conc. of HCl.	Gms. $\text{SO}_2$ per Liter in:		Gm. Equiv. $\frac{1}{2}\text{SO}_2$ per Liter in:		
Aq. Layer.	$\text{CHCl}_3$ Layer.	Aq. Layer.	$\text{CHCl}_3$ Layer.		Aq. Layer.	$\text{CHCl}_3$ Layer.	Aq. Layer.	$\text{CHCl}_3$ Layer.	
1.738	1.123	0.0543	0.0351	0.05	1.86	1.46	0.0581	0.0456	
1.753	1.122	0.0547	0.0350	"	3.07	2.83	0.0960	0.0884	
2.346	1.703	0.0732	0.0532	"	4.28	4.07	0.1336	0.1271	
2.628	1.897	0.0821	0.0592	"	5.34	5.42	0.1667	0.1692	
3.058	2.385	0.0955	0.0745	0.10	1.25	1.41	0.039	0.044	
3.735	3.062	0.1166	0.0956	"	2.78	3.08	0.0868	0.0962	
4.226	3.626	0.1319	0.1132	"	3.86	4.08	0.1199	0.1275	
5.269	4.798	0.1645	0.1498	"	5.161	5.72	0.1612	0.1784	
6.588	6.183	0.2057	0.1930	0.2	1.268	1.51	0.0396	0.0471	
31.92	33.84	0.9968	1.056	"	1.914	2.27	0.0597	0.0710	
33.26	37.25	1.038	1.163	"	2.464	3.04	0.0769	0.0949	
				"	3.967	4.90	0.1239	0.1530	
				0.4	1.202	1.61	0.038	0.0504	
				"	1.894	2.26	0.059	0.0706	

Freezing-point data for mixtures of sulfur dioxide and sulfuryl chloride ( $\text{SO}_2\text{Cl}_2$ ) are given by van der Goot (1913).

**SULFURIC ACID**  $\text{H}_2\text{SO}_4$  (Sulfur Trioxide,  $\text{SO}_3$ ).

SOLUBILITY IN WATER.

(Landolt and Börnstein, "Tabellen," 4th Ed., pp. 472-3, 1912.)

The available data for the freezing-points of mixtures of sulfuric acid and water have been plotted and the most probable values read from the curves. The data are also calculated to  $\text{SO}_3$ . The complete results are given on the following page.



SOLUBILITY OF SULFURIC ACID IN WATER, DETERMINED BY THE  
FREEZING-POINT METHOD.

t°.	Gms. H <sub>2</sub> SO <sub>4</sub> per 100 Gms. Sat. Sol.	Gms. SO <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. H <sub>2</sub> SO <sub>4</sub> per 100 Gms. Sat. Sol.	Gms. SO <sub>3</sub> per 100 Gms. Sat. Sol.	Solid Phase.
-10	16.25	13.25 (1)(5)	Ice	-10	77.75	63.5 (3)	SO <sub>3</sub> ·2H <sub>2</sub> O
-20	24	19.5 (1)(2)(3)	"	0	80.25	65.5 (2)	"
-30	28.5	23.25 (2)	"	+ 8.35*	84.5	68.98 (2)	"
-40	31.25	25.5 (2)	"	8.81	84.5	68.98 (1)	"
-50	33.5	27.25 (1) (2)	"	0	88.25	72 (2)	"
-60	35.25	28.75 (1)	"	-20	91.5	74.75 (1)	"
-70	36.75	30 (2)	"	-30	92.5	75.5 (1)	"
-75	38	31 (2)	" + SO <sub>3</sub> ·5H <sub>2</sub> O	-38	93	76 (2)	" + SO <sub>3</sub> ·H <sub>2</sub> O
-70	39	31.75 (2)	SO <sub>3</sub> ·5H <sub>2</sub> O	-30	93.75	76.5 (4)	SO <sub>3</sub> ·H <sub>2</sub> O
-60	41.5	33.75 (2)	"	-20	95.25	77.75 (4)	"
-50	44	36 (2)	"	-10	96.25	78.5 (1)(4)	"
-40	47.75	39 (2)	"	0	97.75	79.75 (4)	"
-30	53.25	43.25 (2)	"	+10	99.75	81 (4)	"
-25*	57.65	47.06 (2)	"	10.35	100	81.62 (1)(3)(7)(4)	"
-30	61	49.75 (2)	"	10	...	82 (4)	"
-40	65.25	53.25 (2)	"	0	...	83.25 (4)	"
-60	70.75	57.75 (3)	" (unstable)	-10	...	84.5 (4)	"
-70	73.25	59.75 (3)	" " + SO <sub>3</sub> ·2H <sub>2</sub> O	-12	...	85 (4)	" + SO <sub>3</sub> ·4H <sub>2</sub> O
-60	73.50	60 (3)	SO <sub>3</sub> ·2H <sub>2</sub> O (unstable)	-10	...	85.25 (4)	SO <sub>3</sub> ·4H <sub>2</sub> O
-50	74.25	60.5 (3)	"	0	...	86 (4)	"
-50	68	55.5 (2)	SO <sub>3</sub> ·5H <sub>2</sub> O + SO <sub>3</sub> ·3H <sub>2</sub> O	+10	...	86.75 (4)	"
-45	68.5	56 (6)	SO <sub>3</sub> ·3H <sub>2</sub> O	20	...	87.5 (4)	"
-40	71	58 (6)	"	30	...	88.5 (4)	"
-38.9*	73.14	59.69 (6)	"	36*	...	89.89 (4)	"
-40	74.25	60.5 (6)	"	30	...	90.5 (4)	"
-41	74.75	61 (6)	" + SO <sub>3</sub> ·2H <sub>2</sub> O	20	...	91.5 (4)	"
-40	74.75	61 (4)	SO <sub>3</sub> ·2H <sub>2</sub> O	10	...	92.25 (4)	"
-30	75.25	61.5 (4)	"	6.5	...	93 (4)	" + (7)
-20	76.5	62.5 (3)	"				

\* m. pt.

(1) = Pfundler and Schnegg (1875); (2) = Pickering (1890); (3) = Thilo (1892); Pictet (1894); (4) = Knietzsch (1907); (5) = Rüdorff (1862); (6) = Biron (1899); (7) = Marignac (1853). See also Pickering (1890-91); Lespieau (1894) and Giran (1913).

SOLUBILITY OF SULFURIC ACID IN BENZENE SOLUTIONS OF VALERIC  
ACID AT 18°.

(Gurwitsch, 1914.)

The mixtures were shaken with excess of 95.8% H<sub>2</sub>SO<sub>4</sub> at 0° and then brought to equilibrium at 18°.

Gms. Valeric Acid per 100 Gms. Valeric Acid + Benzene.	Gms. H <sub>2</sub> SO <sub>4</sub> per 100 Gms. of the Sat. Solution.
0 = Pure benzene	0
0.584	0.052
1.62	0.104
3.64	0.226
7.60	0.378
17.5	0.454



## TANNIC ACID

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### TANNIC ACID

When a sample of tannic acid of apparently very good quality was added to water at room temperature, the solution increased so greatly in viscosity, that even before the saturation point was reached, it became evident that a satisfactory separation of liquid and solid could not be made. The solubility in water is variously given in the pharmaceutical literature from about 20 to 300 gms. tannic acid per 100 gms. of water. Similarly, the quoted results for the solubility in alcohol vary from about 50 to 400 gms. acid per 100 gms. of alcohol. (Seidell, 1910.)

100 gms. glycerol dissolve 48.8 gms. tannin at 15-16°. (Ossendowski, 1907.)

100 gms. trichlorethylene dissolve 0.012 gm. tannin at 15°. (Wester and Bruins, 1914.)

### TANTALUM Potassium FLUORIDE $\text{TaK}_2\text{F}_7$ .

#### SOLUBILITY IN AQUEOUS HYDROFLUORIC AND POTASSIUM FLUORIDE SOLUTIONS.

(Ruff and Schiller, 1911.)

The tantalum salt was purified by repeated crystallizations from pure anhydrous  $\text{HF}$ . After drying at 120°, it was shaken in platinum flasks for 3 hour periods at constant temperature with  $\text{HF}$  or  $\text{KF}$  solutions or both together. The saturated solutions were filtered by means of a platinum funnel and subjected to analysis.

Mixture Shaken in Pt. Flask.	t°.	Gms. per 100 Gms. Sat. Sol.			Solid Phase.
		$\text{TaH}_5$ .	$\text{KF}$ .	$\text{HF}$ .	
$\text{K}_2\text{TaF}_7 + \text{H}_2\text{O}$	18	0.25	0.12	0.029	$\text{K}_2\text{Ta}_2\text{O}_7\text{F}_6 + \text{K}_2\text{TaF}_7$
" + aq. 4.77% $\text{KF}$	18	0.10	4.79	0.074	"
" + aq. 7.35% $\text{KF}$	16	0.09	6.73	0.015	"
" + aq. 4.47% $\text{HF}$	18	1.33	0.56	4.47	$\text{K}_2\text{TaF}_7$
" + aq. 4.2% $\text{HF}$	18.5	1.24	0.52	4.2	"
" + aq. 24.3% $\text{HF}$	18	5.35	2.25	24.3	"
" + aq. 10.44% $\text{HF}$ + 21.92% $\text{KF}$ }	18	0.036	21.93	10.44	"
" + $\text{H}_2\text{O}$	85	2.18	1.69	0.85	$\text{K}_2\text{Ta}_2\text{O}_7\text{F}_6 + \text{K}_2\text{TaF}_7$
" + aq. 4.77% $\text{KF}$	85	0.96	5.27	1.17	"
" + aq. 4.47% $\text{HF}$	90	5.73	2.41	4.47	$\text{K}_2\text{TaF}_7$
" + aq. 4.2% $\text{HF}$	90	6	2.52	4.2	"
" + aq. 23.3% $\text{HF}$	90	10.9	4.59	24.3	"
" + aq. 21.92% $\text{KF}$ + 10.44% $\text{HF}$ }	90	1.18	22.42	10.44	"

The solid phases were identified only by their crystal forms and it is possible that still others may be present.

### TARTARIC ACIDS $\text{C}_4\text{H}_4(\text{OH})_2(\text{COOH})_2$ . *d, l*, and *racemic*

#### SOLUBILITY OF EACH SEPARATELY IN WATER.

(Leidie, 1882.)

t°.	Grams Tartaric Acid per 100 Gms. $\text{H}_2\text{O}$ .			t°.	Gms. Tartaric Acid per 100 Gms. $\text{H}_2\text{O}$ .		
	Dextro and Laevo Acids.	Racemic Ac. Anhydrous.	Racemic Ac. Hydrated.		Dextro and Laevo Acids.	Racemic Ac. Anhydrous.	Racemic Ac. Hydrated.
0	115.04	8.16	9.23	50	195.0	50.0	59.54
10	125.72	12.32	14.00	60	217.55	64.52	78.33
20	139.44	18.0	20.60	70	243.66	80.56	99.88
25	147.44	21.4	24.61	80	273.33	98.12	124.56
30	156.2	25.2	29.10	90	306.56	117.20	152.74
40	176.0	37.0	43.32	100	343.35	137.80	184.91

100 gms.  $\text{H}_2\text{O}$  dissolve 140.8 gms. tartaric acid at 15°. The Sp. Gr. of the solution is 1.31. (Greenish and Smith, 1901)



SOLUBILITY OF TARTARIC ACID IN ALCOHOLS.  
(Timofeiew, 1894.)

Alcohol.	t°.	Gms. $C_2H_4(OH)_2(COOH)_2$ per 100 Gms. Solvent.	Alcohol.	t°.	Gms. $C_2H_4(OH)_2(COOH)_2$ per 100 Gms. Solvent.
Methyl Alcohol	- 3	67.5	Ethyl Alcohol	+ 23	28.9
"	+ 19.2	70.1	"	39	31.8
"	23	73.2	Propyl Alcohol	- 3	8.74
"	39	77.3	"	+ 19.2	10.85
Ethyl Alcohol	- 3	22.4	"	23	11.85
"	+ 19.2	27.6	"	39	14.4

SOLUBILITY OF TARTARIC ACID IN AQUEOUS ETHYL ALCOHOL SOLUTIONS AT 25°.  
(Seidell, 1910.)

Wt. Per cent $C_2H_5OH$ in Solvent.	$d_{25}^o$ of Sat. Sol.	Gms. $C_2H_4(OH)_2(COOH)_2$ per 100 Gms.		Wt. Per cent $C_2H_5OH$ in Solvent.	$d_{25}^o$ of Sat. Sol.	Gms. $C_2H_4(OH)_2(COOH)_2$ per 100 Gms.	
		Sat. Sol.	Solvent.			Sat. Sol.	Solvent.
0	1.321	57.9	137.5	60	1.142	43.9	78.3
10	1.300	56	127.3	70	1.095	40.2	66.9
20	1.276	54.1	117.9	80	1.040	35.3	54.6
30	1.251	52	108.3	90	0.973	29	40.8
40	1.220	49.6	98.4	95	0.937	25.4	34.1
50	1.184	47	88.6	100	0.905	21.6	27.6

SOLUBILITY OF TARTARIC ACID IN SEVERAL SOLVENTS.

Solvent.	Sp. Gr. of Solvent.	$d_{25}^o$ of Sat. Sol.	t°.	Gms. $C_2H_4(OH)_2(COOH)_2$ per 100 Gms. Gms. Solvent.	Authority.
methyl Alcohol	$d_{20} = 0.817$	0.824	25	3.50	(Seidell, 1910.)
benzene	$d_{25} = 0.873$	0.875	25	0.0086	"
Carbon Tetrachloride	$d_{25} = 1.587$	1.589	25	0.0189	"
ether	$d_{22} = 0.711$	0.715	25	0.61	"
"	...	...	15	0.40	(Bourgoin, 1878.)
dichlorethylene	...	...	15	0.005	(Wester & Bruins, '14.)
trichlorethylene	...	...	15	0.005	"

DISTRIBUTION OF TARTARIC ACID BETWEEN WATER AND ETHER.  
(Pinnow, 1915.)

Results at 15°.			Results at 27°.		
Gms. Mols. per Liter.		$\frac{c}{c'}$ .	Gms. Mols. per Liter.		$\frac{c}{c'}$ .
H <sub>2</sub> O Layer, c.	Ether Layer, c'.		H <sub>2</sub> O Layer, c.	Ether Layer, c'.	
1.402	0.0072	197	1.625	0.0070	233
0.790	0.0037	216	0.857	0.0033	259
0.446	0.0022	210	0.427	0.0016	268

F-pt. data are given for mixtures of the *d* and *racemic* modifications of dimethyl ether of tartaric acid, and for mixtures of the *d* and *racemic* modifications of diethyl ether of diacetyl tartaric acid by Roozeboom (1899). Results for mixtures of the *d* and *i* forms of the diformalic derivative of *racemic* tartaric acid by Ringer (1902). Results for mixtures of *d* tartaric acid and *racemic* acid ester and for *d* acetyl tartrate and *racemic* acid ester are given by Beck (1904). Data for mixtures of *d* and *l* tartaric acid and for mixtures of *d* and *i* dimethyl ester of tartaric acid are given by Centnerszwer (1899).

**γ-TARTARIC ACID** (Methyl Succinic Acid)  $CH_3CH(COOH).CH_2(COOH)$ .  
100 gms. H<sub>2</sub>O dissolve 51 gms.  $CH_3CH(COOH).CH_2COOH$  at 19.5°.  
(Timofeiew, 1894.)



# PyroTARTARIC ACID

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## SOLUBILITY IN ALCOHOLS. (Timofeiew, 1894.)

Alcohol.	t°.	Gms. Acid per 100 Gms. Solvent.	Alcohol.	t°.	Gms. Acid per 100 Gms. Solvent.
Methyl Alcohol	-18.5	53	Ethyl Alcohol	19.5	72.4
"	+19	109.8	Propyl Alcohol	19	44.9
"	+19.5	112.5	"	19.5	47.1
Ethyl Alcohol	+19	70.8			

100 gms. 95% formic acid dissolve 17.8 gms. pyrotartaric acid at 18.5°.  
(Aschan, 1913.)

## TERPIN HYDRATE $C_{10}H_{18}(OH)_2 \cdot H_2O$ .

100 cc.  $H_2O$  dissolve 0.36 gm. terpin hydrate at 15-20°.

100 cc. 90% alcohol dissolve 7.1 gms. terpin hydrate at 15-20°.  
(Squire and Caines, 1905.)

## TELLURIUM Te.

100 gms. methylene iodide,  $CH_2I_2$ , dissolve 0.1 gm. Te at 12°.  
(Reigen, 1893.)

## DISTRIBUTION OF TELLURIUM BETWEEN AQUEOUS HYDROCHLORIC ACID AND ETHER AT ROOM TEMPERATURE. (Mylius, 1911.)

When 1 gm. of tellurium as the chloride,  $TeCl_4$ , is dissolved in 100 cc. of aqueous HCl and shaken with 100 cc. of ether, the following per cents of the metal enter the ethereal layers. With 20% HCl, 34 per cent; 15% HCl, 12 per cent; 10% HCl, 3 per cent; 5% HCl, 0.2 per cent and with 1% HCl, only a trace of the tellurium.

Fusion-point curves for mixtures of tellurium and each of the following metals are given by Pelabon (1909): Sb, Sn, Pb, Ag, Au and As. Results for mixtures of Te and Zn are given by Kobayashi (1911-12).

## TELLURIC ACID $H_2TeO_4 \cdot 2H_2O$ .

### SOLUBILITY IN WATER. (Mylius, 1901.)

t°.	Gms. $H_2TeO_4$ per 100 Gms. Sol.	Mols. $H_2TeO_4$ per 100 Mols. $H_2O$ .	Solid Phase.	t°.	Gms. $H_2TeO_4$ per 100 Gms. Sol.	Mols. $H_2TeO_4$ per 100 Mols. $H_2O$ .	Solid Phase.
0	13.92	1.51	$H_2TeO_4 \cdot 6H_2O$	30	33.36	4.67	$H_2TeO_4 \cdot H_2O$
5	17.84	2.03	"	40	36.38	5.33	"
10	26.21	3.31	"	60	43.67	7.04	"
15	32.79	4.55	"	80	51.55	9.93	"
10	25.29	3.15	$H_2TeO_4 \cdot 2H_2O$	100	60.84	14.52	"
18	28.90	3.82	"	110	67	19	"

## TELLURIUM DOUBLE SALTS

### SOLUBILITY OF TELLURIUM DOUBLE BROMIDES AND CHLORIDES IN AQUEOUS HYDROCHLORIC AND HYDROBROMIC ACIDS AT 22°. (Wheeler, 1893a.)

Tellurium Double Salt.	Formula.	Solvent.	Gms. Double Salt per 100 Gms. Solvent	
			of 1.49 Sp. Gr.	of 1.08 Sp. Gr.
Te Caesium Bromide	$TeBr_4 \cdot 2CsBr$	Aq. HBr	0.02	0.13
Te Potassium Bromide	$TeBr_4 \cdot 2KBr$	"	6.57	52.90
Te Rubidium Bromide	$TeBr_4 \cdot 2RbBr$	"	0.25	3.88
Te Caesium Chloride	$TeCl_4 \cdot 2CsCl$	Aq. HCl*	0.05	0.78
Te Rubidium Chloride	$TeCl_4 \cdot 2RbCl$	"	0.34	13.09

\* Sp. Gr. of Aq. HCl solutions 1.2 and 1.05 respectively.



**TELLURIUM TetraIODIDE  $\text{TeI}_4$ .**

SOLUBILITY IN MIXTURES OF AQUEOUS HYDRIODIC ACID AND IODINE AT  $25^\circ$ .  
(Menke, 1912.)

Equal amounts of  $\text{TeI}_4 + \text{I} + 65$  wt. % HI solution were shaken in sealed tubes for 10 days. Both the clear saturated solution and the solid phase were analyzed.

Position of Original Mixture in Gms.		Gms. per 100 Gms. Solution.		Solid Phase.
I.	64% HI.	$\text{TeI}_4$ .	I.	
1.5	19.25	12	11.7	Small amt. $\text{TeI}_4 \cdot \text{HI} \cdot 8\text{H}_2\text{O}$
0.5	9.61	13	0	Much "
0.5	9.61	13.5	8.2	" "
3	8.99	20	21.8	small amt. "
s None	5 (cc.)	9	0.19	$\text{TeI}_4 \cdot \text{HI} \cdot 8\text{H}_2\text{O}$
9	9.10	10	52.4	Iodine
10	9.27	15	47.7	"
7	9.02	17.5	47.9	"
Excess	5 (cc.)	None	61.1	"

**TELLURIUM ALUMS**

SOLUBILITY IN WATER AT  $25^\circ$ .  
(Locke, 1901.)

Alum.	Formula.	Salt per 100 Grams $\text{H}_2\text{O}$ .		
		Gms. Anhydrous.	Gms. Hydrated.	Gm. Mols.
Aluminum Alum	$\text{TiAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	7.5	11.78	0.0177
Sodium Alum	$\text{TiV}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	25.6	43.31	0.0573
Chromium Alum	$\text{TiCr}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	10.48	16.38	0.0212
Iron Alum	$\text{TiFe}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$	36.15	64.6	0.0799

Also pp. 31 and 32.

**TELLURIUM BROMATE  $\text{TiBrO}_3$ .**

1 liter saturated aqueous solution contains 3.463 gms.  $\text{TiBrO}_3$  at  $19.9^\circ$  (Böttger, 1903) and 7.355 gms. at  $39.75^\circ$ .  
(Noyes and Abbot, 1895.)

**TELLURIUM BROMIDE  $\text{TiBr}$ .**

1 liter sat. aqueous solution contains 0.238 gm.  $\text{TiBr}$  at  $0.13^\circ$ , 0.289 gm. at  $18.233^\circ$  at  $18^\circ$  and 0.579 gm. at  $25.68^\circ$ .  
(Kohlrausch, 1908.)

SOLUBILITY OF TELLURIUM BROMIDE IN AQUEOUS SOLUTIONS OF TELLURIUM NITRATE AT  $68.5^\circ$ .

Gms. Mols. per Liter.		Gms. per Liter.	
$\text{TiNO}_3$ .	$\text{TiBr}$ .	$\text{TiNO}_3$ .	$\text{TiBr}$ .
0	0.00869	0	2.469
0.0163	0.00410	4.336	1.164
0.0294	0.00289	7.820	0.821
0.0955	0.00148	25.400	0.420

Additional data for mixtures of  $\text{TiBr} + \text{TiCl}$ ,  $\text{TiBr} + \text{TiI}$  and  $\text{TiCl} + \text{TiI}$  are given by Frank Meyer (1906). Results for  $\text{TiCl} + \text{SnCl}_2$  and  $\text{TiCl} + \text{ZnCl}_2$  are given by Frank Meyer (1914).

**TELLURIUM CARBONATE  $\text{Ti}_2\text{CO}_3$ .**

SOLUBILITY IN WATER.  
(Crookes, 1864; Lamy, 1863.)

$t^\circ$ .	$15.5^\circ$ .	$18^\circ$ .	$62^\circ$ .	$100^\circ$ .	$100.8^\circ$ .
$\text{Ti}_2\text{CO}_3$ per 100 gms $\text{H}_2\text{O}$	4.2 (C.)	5.23	12.85	27.2 (C.)	22.4



# **THALLIUM CHLORATE**

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## **THALLIUM CHLORATE $\text{TiClO}_3$ .**

### **SOLUBILITY IN WATER.**

(Muir, 1876.)

t°.	0°.	20°.	50°.	80°.	100°.
Gms. $\text{TiClO}_3$ per 100 gms. $\text{H}_2\text{O}$	2	3.92	12.67	36.65	57.31

One liter sat. aq. solution contains 38.51 gms.  $\text{TiClO}_3$  at 20°. (Noyes and Farrel, 1911.)

One liter of aqueous solution, saturated with both salts, contains 30.4 gms.  $\text{TiClO}_3$  + 34.43 gms.  $\text{Ti}_2\text{SO}_4$  at 20°. (Noyes and Farrel, 1911.)

### **SOLUBILITY OF MIXED CRYSTALS OF THALLIUM CHLORATE AND POTASSIUM CHLORATE IN WATER AT 10°.**

(Rooseboom, 1891.)

NOTE. — Solutions of the two salts were mixed in different proportions and allowed to crystallize, such amounts being taken that not more than one or two grams would separate from one liter.

Gms. per 1000 cc. Solution.		Mg. Mols. per 1000 cc. Solution.		Sp. Gr. of Solutions.	Mols. per cent $\text{KClO}_3$ in Mixed Crystals.
$\text{TiClO}_3$ .	$\text{KClO}_3$ .	$\text{TiClO}_3$ .	$\text{KClO}_3$ .		
25.637	...	89.14	...	1.0210	0
19.637	6.884	68.27	56.15	1.0222	2
12.001	26.100	41.73	212.89	1.0278	12.61
9.036	40.064	31.42	326.79	1.0338	25.01
7.885	46.497	27.42	379.26	1.0359	36.30-97.93
7.935	46.535	27.60	379.57	1.0360	
6.706	46.410	23.32	378.55	1.0357	
6.723	47.109	23.37	384.25	1.0363	99.28
4.858	47.312	16.89	385.91	1.0345	99.60
2.769	47.134	9.63	384.46	1.0330	99.62
...	49.925	...	407.22	1.0330	99.67
					100

### **SOLUBILITY OF MIXED CRYSTALS OF THALLIUM CHLORATE AND POTASSIUM CHLORATE IN WATER AT DIFFERENT TEMPERATURES.**

(Quoted by Rabe, 1902.)

100 gms.  $\text{H}_2\text{O}$  dissolve 2.8 gms.  $\text{TiClO}_3$  + 3.3 gms.  $\text{KClO}_3$  at 0°.

"  $\text{H}_2\text{O}$  dissolve 10 gms.  $\text{TiClO}_3$  + 1.5 gms.  $\text{KClO}_3$  at 15°.

"  $\text{H}_2\text{O}$  dissolve 12.67 gms.  $\text{TiClO}_3$  + 16.2 gms.  $\text{KClO}_3$  at 50°.

"  $\text{H}_2\text{O}$  dissolve 57.3 gms.  $\text{TiClO}_3$  + 48.2 gms.  $\text{KClO}_3$  at 100°.

## **THALLIUM PerCHLORATE $\text{TiClO}_4$ .**

### **SOLUBILITY IN WATER.**

(Carlson, 1910.)

t°.	Sp. Gr. Sat. Sol.	Gms. $\text{TiClO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Sp. Gr. Sat. Sol.	Gms. $\text{TiClO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .
0	1.060	6	50	1.251	39.62
10	1.075	8.04	70	1.430	65.32
30	1.146	19.72	80	1.520	81.49

100 gms.  $\text{H}_2\text{O}$  dissolve 10 gms.  $\text{TiClO}_4$  at 15° and 166.6 gms. at 100°.

(Roscoe, 1866.)



THALLIUM CHLORIDE  $\text{TlCl}$ .

## SOLUBILITY IN WATER.

(Average curve from results of Noyes, 1892; Böttger, 1903; Kohlrausch, 1904; Hebbertling; Crookes; Lamy. The results of Berkeley, 1904 are also given.)

°.	Gms. $\text{TlCl}$ per Liter.		°.	Gms. $\text{TlCl}$ per Liter.		°.	Gms. $\text{TlCl}$ per Liter.	
0	2.1 (av.)	1.7 (B.)	25	3.86	4	60	8	10.2
10	2.5	2.4	30	4.2	4.6	80	12	16
20	3.3	3.4	40	5.2	6	100	18	24.1 (99.3°)
			50	6.3	8			

The results of Berkeley are in terms of gms. of  $\text{TlCl}$  per 1000 gms.  $\text{H}_2\text{O}$  but the densities of the solutions are approximately 1 in all cases, except for temperatures above 60°, the differences are negligible. The Sp. Gr. of the sat. l. at 99.3° is 0.9787 and the figure 24.1, therefore, becomes 23.58 gms. per liter. One liter sat. solution in water contains 2.27 gms.  $\text{TlCl}$  at 9.54°, 3.05 gms. at 17°, and 3.97 gms. at 25.76°. (Kohlrausch, 1908.)

## SOLUBILITY OF THALLIUM CHLORIDE AT 25° IN AQUEOUS SOLUTIONS OF:

## Acetic Acid.

(Hill, 1917.)

## Nitric Acid.

(Hill and Simmons, 1909.)

Normality of $\text{CH}_3\text{COOH}$ .	TlCl per Liter.		Normality of Aq. $\text{HNO}_3$ .	$d_{25}$ of Sat. Sol.	TlCl per Liter.	
	Gms.	Gm. Equiv.			Gms.	Gm. Equiv.
0	3.8515	0.016085	0	0.996	3.951	0.0165
0.0501	3.8375	0.016027	0.4977	1.0184	5.937	2.475
0.0958	3.8326	0.016006	1.0046	1.0359	6.882	2.875
0.263	3.7503	0.015662	2.0452	1.0705	8.143	3.401
0.524	3.6539	0.015258	4.0170	1.1362	9.925	4.145

SOLUBILITY OF THALLIUM CHLORIDE IN AQUEOUS SOLUTIONS OF SALTS  
WITH A COMMON ION AT 25°.

(Noyes, 1892.)

Aqueous Solution of:	Gms. Equiv. Added Salt per Liter.	Gms. Equiv. Dissolved $\text{TlCl}$ per Liter.	Aqueous Solution of:	Gms. Equiv. Added Salt per Liter.	Gms. Equiv. Dissolved $\text{TlCl}$ per Liter.
Water alone	0	0.01612	$\text{MgCl}_2$	0.025	0.00904
$\text{NH}_4\text{Cl}$	0.025	0.00877	"	0.050	0.00618
"	0.05	0.00593	"	0.10	0.00413
"	0.20	0.00271	"	0.20	0.00275
$\text{BaCl}_2$	0.05	0.00620	$\text{MnCl}_2$	0.025	0.00808
"	0.10	0.00425	"	0.05	0.00617
$\text{CdCl}_2$	0.025	0.01040	"	0.10	0.00412
"	0.05	0.00780	"	0.20	0.00286
"	0.10	0.00578	$\text{KCl}$	0.025	0.00872
"	0.20	0.00427	"	0.05	0.00593
$\text{CaCl}_2$	0.025	0.00899	"	0.10	0.00399
"	0.05	0.00624	"	0.20	0.00265
"	0.10	0.00417	"	0.80	0.00170
"	0.20	0.00284	$\text{NaCl}$	0.025	0.00869
$\text{CuCl}_2$	0.025	0.00905	"	0.05	0.00592
"	0.05	0.00614	"	0.10	0.00395
"	0.10	0.00422	"	0.20	0.00271
"	0.20	0.00291	$\text{TlClO}_3$	0.025	0.00897
$\text{HCl}$	0.025	0.00869	"	0.025	0.00894
"	0.05	0.00585	$\text{TlNO}_3$	0.025	0.00883
"	0.10	0.00384	"	0.05	0.00626
"	0.20	0.00254	"	0.10	0.00423



SOLUBILITY OF THALLIUM CHLORIDE IN AQUEOUS SALT SOLUTIONS AT 25°.  
 (Noyes, 1890; Noyes and Abbott, 1895; Geffcken, 1904.)

Aq. Salt Solution.	G. Mols. per Liter.		Gms. per Liter.	
	Salt.	TlCl.	Salt.	TlCl.
Ammonium Nitrate $\text{NH}_4\text{NO}_3$	0	0.01612	0	3.861 (G.)
"	0.5	0.02587	40.02	6.209
"	1	0.03121	80.05	7.473
"	2	0.03966	160.10	9.497
Barium Chloride $\text{BaCl}_2$	0.0283	0.00857	5.895	2.052 (N.)
"	0.1468	0.00323	30.59	0.773
Cadmium Sulfate $\text{CdSO}_4$	0.030	0.0206	6.255	4.933 (N.)
"	0.0787	0.0254	16.41	6.081
"	0.1574	0.0309	32.82	7.399
Hydrochloric Acid $\text{HCl}$	0.0283	0.00836	1.032	2.002 (N.)
"	0.0560	0.00565	2.043	1.353
"	0.1468	0.00316	5.357	0.757
Lithium Nitrate $\text{LiNO}_3$	0.5	0.02542	34.53	6.085 (G.)
"	1	0.03035	69.07	7.266
"	2	0.03785	138.14	9.063
"	3	0.04438	207.21	10.630
Potassium Chlorate $\text{KClO}_3$	0.5	0.0237	61.28	5.674 (G.)
Potassium Nitrate $\text{KNO}_3$	0.015	0.0170	1.517	4.070 (N.)
"	0.030	0.0179	3.033	4.286
"	0.0787	0.0192	7.775	4.597
"	0.1574	0.0212	15.920	5.076
"	0.5	0.0257	50.55	6.153 (G.)
"	1	0.0308	101.11	7.375
"	2	0.0390	202.22	9.340
Sodium Acetate $\text{CH}_3\text{COONa}$	0.015	0.0168	1.231	4.023 (N.)
"	0.030	0.0172	2.462	4.118
"	0.0787	0.0185	6.46	4.430
"	0.1574	0.0196	12.92	4.693
Sodium Nitrate $\text{NaNO}_3$	0.5	0.02564	42.50	6.139 (G.)
"	1	0.03054	85.01	7.313
"	2	0.03851	170.02	9.221
"	3	0.04544	255.03	10.88
"	4	0.05128	340.12	12.28
Sodium Chlorate $\text{NaClO}_3$	0.5	0.02320	53.25	5.555 (G.)
"	1	0.02687	106.5	6.433
"	2	0.03060	213	7.326
"	3	0.03303	319.5	7.909
"	4	0.03850	426	9.215
Thallium Bromate $\text{TlBrO}_3$ (at 39.75°)	0.01567	0.01959	5.201	4.690 (N. & A.)
Thallium Nitrate $\text{TlNO}_3$	0.0283	0.0083	7.518	1.987 (N.)
"	0.0560	0.00571	14.89	1.368
"	0.1468	0.00332	39.05	0.795
Thallium Sulfate $\text{Tl}_2\text{SO}_4$	0.0283	0.00886	14.27	2.121 (N.)
"	0.0560	0.00624	28.23	1.494
Thallium Thiocyanate $\text{TlSCN}$	0.0107	0.0119	2.802	2.849 (N.)
" (at 39.75°)	0.02149	0.01807	5.632	4.326 (N. & A.)

NOTE. — In the case of the results for thallium bromate and thallium thiocyanate at 39.75°, the solutions were saturated with respect to these salts as well as with respect to thallium chloride.



ITY OF THALLIUM CHLORIDE IN AQUEOUS SOLUTIONS OF SALTS AT 25°  
(Bray and Winninghoff, 1911.)

Solvent.		Saturated Solution.		
Gms. Equiv. Salt. per Liter.	$d_{20}$ of Aq. Solvent.	Gms. Equiv. Salt per Liter.	$d_{20}$ of Sat. Sol.	Gms. Equiv. TlCl per Liter.
...	...	...	0.9994	0.01607
0.02001	0.9973	0.020	1.0009	0.01716
0.05000	0.9992	0.04997	1.0028	0.01826
0.10005	1.0023	0.09998	1.0063	0.01961
0.3002	1.0145	0.3000	1.0194	0.02313
1.0005	1.0568	0.9996	1.0632	0.03072
0.01997	0.9975	0.01996	1.0012	0.01779
0.05000	0.9995	0.04996	1.0037	0.01942
0.1000	1.0030	0.09989	1.0074	0.02137
0.3000	1.0167	0.29966	1.0221	0.02600
1	1.0628	0.9986	1.0698	0.03416
0.0200	1.0007	0.01999	1.0028	0.01034
0.0500	1.0076	0.04999	1.0090	0.006772
0.1000	1.0191	0.09997	1.0200	0.004679

ter of water dissolves 2.7 gms. *thallo thallic chloride* 3TlCl.TlCl<sub>3</sub> at 15°-17°,  
gms. at 100°.

(Crookes, 1864; Lamy; Hebbertling.)

**IUM CHROMATE** Tl<sub>2</sub>CrO<sub>4</sub>.

ns. H<sub>2</sub>O dissolve 0.03 gm. Tl<sub>2</sub>CrO<sub>4</sub> at 60°, and 0.2 gm. at 100°.

(Browning and Hutchins, 1900.)

iter of aq. 31 per cent KOH solution dissolves 18 gms. Tl<sub>2</sub>CrO<sub>4</sub>.

(Lepierre and Lachand, 1891.)

iter of H<sub>2</sub>O dissolves 0.35 gm. thallium trichromate, Tl<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>, at 15°,  
gms. at 100°.

(Crookes, 1864.)

**IUM CYANIDE** TlCN and Double Cyanides.

SOLUBILITY IN WATER.

(Fronmüller, 1878.)

Cyanide.	Formula.	Gms. Salt per 100 Gms. H <sub>2</sub> O.
ide	TlCN	16.8 at 28.5°.
liti Cyanide	Tl <sub>2</sub> Co(CN) <sub>6</sub>	3.6 at 0°; 5.86 at 9.5°; 10.04 at 19.5°.
Cyanide	2TlCN.Zn(CN) <sub>2</sub>	8.7 at 0°; 15.2 at 14°; 29.6 at 31°.
o Cyanide	Tl <sub>4</sub> Fe(CN) <sub>6</sub> .2H <sub>2</sub> O	0.37 at 18°; 3.93 at 101°. (Lamy.)

**IUM FLUORIDE** TlF.

ns. H<sub>2</sub>O dissolve 80 gms. TlF at 15°.

(Büchner, 1865.)

**IUM HYDROXIDE** TlOH.

SOLUBILITY IN WATER.

(Bahr, 1911.)

$d_{20}$ of Sat. Sol.	Mols. TlOH per Liter.	Gms. TlOH per Liter.	t°.	Mols. TlOH per Liter.	Gms. TlOH per Liter.
1.231	1.151	254.4	44.5	2.442	539.8
1.317	1.554	343.4	54.1	2.940	649.7
1.342	1.803	398.5	64.6	3.601	795.8
1.377	1.861	411.2	78.5	4.673	1033
1.417	2.075	458.6	90	5.705	1261
1.446	2.240	495	99.2	6.708	1483

olutions were stirred by means of a current of hydrogen. The solid phase  
me at all temperatures.



**THALLIUM IODATE**

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**THALLIUM IODATE  $\text{TiIO}_3$ .**One liter aq. solution contains 0.578 gm.  $\text{TiIO}_3$  at 20°.

(Böttger, 1903.)

One liter aqueous solution contains  $1.76 \cdot 10^{-4}$  mols.  $\text{TiIO}_3$  at 25° = 0.667 gm., determined by means of electrodes of the third kind.

(Spencer, 1912.)

**THALLIUM IODIDE  $\text{TII}$** 

One liter sat. solution in water contains 0.0362 gm. at 9.9°, 0.056 gm. at 18.1° and 0.0847 gm. at 26°.

(Kohlrausch, 1908.)

**SOLUBILITY OF THALLIUM IODIDE IN WATER.**

(Average results from Böttger, 1903; Kohlrausch, 1904-05; Werther; Crookes, 1864; Lamy; Heberling.)

t°.	0°.	20°.	40°.	60°.	80°.	100°.
Gms. $\text{TII}$ per liter	0.02	0.06	0.15	0.35	0.70	1.20

One liter of 2½ per cent aq. ammonia dissolves 0.761 gm.  $\text{TiCl}$ .One liter of 6½ per cent aq. ammonia dissolves 0.758 gm.  $\text{TiCl}$ .One liter of 90 per cent alcohol dissolves 0.0038 gm.  $\text{TiCl}$ .One liter of 50 per cent alcohol dissolves 0.027 gm.  $\text{TiCl}$ .

(Long, 1881.)

Data for the temperatures of solidification of mixtures of  $\text{TII}$  and  $\text{TINO}_3$  are given by Van Eyk (1901).**THALLIUM NITRATE  $\text{TINO}_3$ .****SOLUBILITY IN WATER.**

(Berkeley, 1904; see also Etard, 1894; Crookes; Lamy.)

t°.	Gms. $\text{TINO}_3$ per 100 Gms.		t°.	Gms. $\text{TINO}_3$ per 100 Gms.	
	Solution.	Water.		Solution.	Water.
0	3.76	3.91	60	31.55	46.2
10	5.86	6.22	70	41.01	69.5
20	8.72	9.55	80	52.6	111.0
30	12.51	14.3	90	66.66	200.0
40	17.33	20.9	100	80.54	414.0
50	23.33	30.4	105	85.59	594.0

Solid phase.  $\text{TINO}_3$  rhombic.100 gms.  $\text{H}_2\text{O}$  dissolve 43.5 gms.  $\text{TINO}_3$  + 104.2 gms.  $\text{KNO}_3$  at 58°. (Rabe, 1902.)**THALLIUM OXALATE  $\text{Ti}_2\text{C}_2\text{O}_4$ .**One liter of saturated aqueous solution contains 15.77 gms.  $\text{Ti}_2\text{C}_2\text{O}_4$  at 20°, and 18.69 gms. at 25°.

(Böttger, 1903; Abegg and Spencer, 1905.)

**SOLUBILITY OF THALLIUM OXALATE AT 25° IN AQ. SOLUTIONS OF:**

Thallium Nitrate. (Abegg and Spencer.)				Potassium Oxalate. (Abegg and Spencer.)			
Mol. Concentration.		Grams per Liter.		Mol. Concentration.		Grams per Liter.	
$\text{TINO}_3$ .	$\text{Ti}_2\text{C}_2\text{O}_4$ .	$\text{TINO}_3$ .	$\text{Ti}_2\text{C}_2\text{O}_4$ .	$\text{K}_2\text{C}_2\text{O}_4$ .	$\text{Ti}_2\text{C}_2\text{O}_4$ .	$\text{K}_2\text{C}_2\text{O}_4$ .	$\text{Ti}_2\text{C}_2\text{O}_4$ .
0.0	0.03768	0.00	18.69	0.0498	0.0351	8.281	17.42
0.04114	0.0264	10.95	13.10	0.0996	0.03565	16.57	17.69
0.0799	0.0195	21.26	9.68	0.2467	0.0390	41.02	19.36
0.1597	0.01235	42.51	6.128	0.4886	0.04506	81.25	22.37
				0.9785	0.05536	162.6	27.48

**THALLIUM PHOSPHATE (ortho)  $\text{Ti}_2\text{PO}_4$ .**One liter of sat. aqueous solution contains 4.97 gms.  $\text{Ti}_2\text{PO}_4$  at 15° and 6.71 gms. at 100°.

(Crookes, 1864.)



THALLIUM PICRATE  $\text{TiOC}_6\text{H}_5(\text{NO}_2)_4$ .SOLUBILITY IN WATER.  
(Rabe, 1901.)

t°.	Gms. $\text{TiOC}_6\text{H}_5(\text{NO}_2)_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{TiOC}_6\text{H}_5(\text{NO}_2)_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Solid Phase.
0	0.135	Monoclinic Red	45	1.04	Triclinic Yellow
18	0.36	"	47	1.10	"
30	0.575	"	50	1.205	"
40	0.825	"	60	1.73	"
47	1.14	"	70	2.43	"

ns.  $\text{H}_2\text{O}$  simultaneously sat. with both salts dissolve:

gm.  $\text{C}_6\text{H}_5(\text{NO}_2)_2\text{OTl}$  + 0.36 gm.  $\text{C}_6\text{H}_5(\text{NO}_2)_2\text{OK}$  at 0°.  
 " " + 0.44 " " 15°.  
 " " + 0.23 " " 20°. (Rabe, 1901.)

SOLUBILITY OF THALLIUM PICRATE IN METHYL ALCOHOL.  
(Rabe, 1901.)

Gms. $\text{TiOC}_6\text{H}_5(\text{NO}_2)_4$ per 100 Gms. $\text{CH}_3\text{OH}$ .	Solid Phase.	t°.	Gms. $\text{TiOC}_6\text{H}_5(\text{NO}_2)_4$ per 100 Gms. $\text{CH}_3\text{OH}$ .	Solid Phase.
0.39	Red Form (monoclinic)	45	1.195	Yellow Form (triclinic)
0.59	"	48	1.265	"
0.70	"	50	1.325	"
0.795	"	53	1.41	"
0.90	"	57	1.54	"
1.02	"	60	1.65	"
1.17	"	65	1.84	"
1.265	"			

THALLIUM SELENATE  $\text{Ti}_2\text{SeO}_4$ .

## SOLUBILITY IN WATER.

t°.	Gms. $\text{Ti}_2\text{SeO}_4$ per 100 Gms. $\text{H}_2\text{O}$ .	Authority.
9.3	2.13	(Tutton, 1907.)
12	2.4	"
20	2.8	(Glauser, 1910.)
80	8.5	"
100	10.86	(Tutton, 1907.)

THALLIUM SULFATE  $\text{Ti}_2\text{SO}_4$ .SOLUBILITY IN WATER.  
(Berkeley, 1904; see also Crookes; Lamy.)

Gms. $\text{Ti}_2\text{SO}_4$ per 100 Gms.		t°.	Gms. $\text{Ti}_2\text{SO}_4$ per 100 Gms.	
Solution.	Water.		Solution.	Water.
2.63	2.70	60	9.89	10.92
3.57	3.70	70	11.31	12.74
4.64	4.87	80	12.77	14.61
5.80	6.16	90	14.19	16.53
8.44	9.21	99.7	15.57	18.45

ns.  $\text{H}_2\text{O}$  dissolve 3.36 gms.  $\text{Ti}_2\text{SO}_4$  at 6.5°, 4.3 gms. at 12° and 19.14 gms. (Tutton, 1907.)

er sat. solution in water contains 48.59 gms.  $\text{Ti}_2\text{SO}_4$  at 20° (Noyes and 311) and 54.59 gms. at 25° (Noyes and Stewart, 1911).

ns.  $\text{H}_2\text{O}$  simultaneously sat. with both salts dissolve:

gms.  $\text{Ti}_2\text{SO}_4$  + 10.3 gms.  $\text{K}_2\text{SO}_4$  at 15°.  
 " " + 16.4 " " 62°.  
 " " + 26.2 " " 100°. (Rabe, 1902.)



## THALLIUM SULFATE

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### SOLUBILITY OF THALLIUM SULFATE IN AQUEOUS SOLUTIONS AT 25° (Noyes and Stewart, 1911.)

Solvent.		Saturated Solution.				
Salt Present.	Formula Wts. Salt per Liter.	Formula Wts. Salt per Liter.	Formula Wts. Tl <sub>2</sub> SO <sub>4</sub> per Liter.	d <sub>m</sub> of Sat. Sol.	Gms. Salt per Liter.	Gms. Tl <sub>2</sub> SO <sub>4</sub> per Liter.
TlNO <sub>3</sub>	0.099±	0.0996	0.08365	...	26.51	42.17
Na <sub>2</sub> SO <sub>4</sub>	0.04995	0.0497	0.1080	1.0531	7.062	54.44
"	0.20	0.1988	0.1173	1.0754	28.25	59.13
NaHSO <sub>4</sub>	0.1015	0.1010	0.1161	1.0596	12.12	58.53
H <sub>2</sub> SO <sub>4</sub>	0.04967	0.0494	0.1172	1.0540	4.878	59.09
"	0.09933	0.0987	0.1249	1.0604	9.747	62.95

### SOLUBILITY OF THALLIUM SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 25°. (D'Ans and Fritzsche, 1909.)

Mols. per 1000 Gms. Sat. Sol.		Solid Phase.	Mols. per 1000 Gms. Sat. Sol.		Solid Phase.
$H_2SO_4$ .	$Tl_2SO_4$ .		$H_2SO_4$ .	$Tl_2SO_4$ .	
0	0.103	$Tl_2SO_4$	4.89	0.59	$TlHSO_4$
2.99	0.46	" + $Tl_2H(SO_4)_2$	4.92	0.66	"
4.25	0.61	$Tl_2H(SO_4)_2 + TlHSO_4$	4.78	0.75	"
4.55	0.56	$TlHSO_4$	4.26	1.01	"
4.79	0.55	"	4.03	1.08	"

## THALLIUM DOUBLE SULFATES

### SOLUBILITY IN WATER AT 25°. (Locke, 1901.)

Double Sulfate.	Formula.	Salt per 100 cc. $H_2O$ .	
		Gms. Anhydrous.	Gms. Mols
Tl Copper Sulfate	$Tl_2Cu(SO_4)_2 \cdot 6H_2O$	8.1	0.0122
Tl Nickel Sulfate	$Tl_2Ni(SO_4)_2 \cdot 6H_2O$	4.61	0.007
Tl Zinc Sulfate	$Tl_2Zn(SO_4)_2 \cdot 6H_2O$	8.6	0.0129

## THALLIUM SULFIDE $Tl_2S$ .

One liter of sat. aqueous solution contains 0.215 gm.  $Tl_2S$  at 20°. (Böttger, 1903.)

A diagram and discussion of the fusion points of  $Tl_2S + S$ ,  $Tl_2S + Se$  and  $Tl_2S + Te$  are given by Pelabon, 1907.

## THALLIUM SULFITE $Tl_2SO_3$ .

100 gms.  $H_2O$  dissolve 3.34 gms.  $Tl_2SO_3$  at 15.5°. (Seubert and Elten, 1892)

## THALLIUM THIOCYANATE $TlSCN$ .

### SOLUBILITY IN WATER AND IN AQUEOUS SALT SOLUTIONS. (Böttger, 1903; Noyes, 1890; Noyes and Abbott, 1895.)

One liter sat. aq. solution contains 3.154 gms.  $TlSCN$  at 20°, 3.905 gms. at 25 and 7.269 gms. at 39.75°.

Aq. Salt Solution.	t°.	Gms. Mols. per Liter.		Gms. per Liter.	
		Salt.	$TlSCN$ .	Salt.	$TlSCN$ .
Thallium Bromate $TlBrO_3$ (excess)	39.75	0.01496	0.0221	4.966	5.793 (N. & A)
Thallium Nitrate $TlNO_3$	25	0.0227	0.00852	6.04	2.233 (N.)
"	25	0.0822	0.00406	21.88	1.064
Potassium Thiocyanate, $KSCN$	25	0.0227	0.0083.	2.208	2.176 (N.)



**THALLIUM VANADATES.**

SOLUBILITY IN WATER. (Carnelly, 1873; Liebig, 1860.)

Vanadate.	Formula.	Gms. Vanadate per 100 Gms. H <sub>2</sub> O.	
		At 15°.	At 100°.
Tl. meta vanadate	TlVO <sub>3</sub>	0.087 (11°)	0.21
" ortho vanadate	Tl <sub>2</sub> VO <sub>3</sub>	1	1.74
" pyro vanadate	Tl <sub>4</sub> V <sub>2</sub> O <sub>7</sub>	0.20 (14°)	0.26
" vanadate	Tl <sub>12</sub> V <sub>4</sub> O <sub>28</sub>	0.107	0.29

**THEBAINE** (Para Morphine) C<sub>18</sub>H<sub>21</sub>NO<sub>3</sub>.

SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. Thebaine per 100 Gms. Solvent.	Authority.
92 Wt. % Alcohol	25	0.1	...
Ether	10	0.71	...
Aniline	20	30	(Scholtz, 1912.)
Pyridine	20	9	"
Piperidine	20	2	"
Diethylamine	20	0.7	"

**THEOBROMINE** (Dimethyl Xanthine) C<sub>8</sub>H<sub>8</sub>(CH<sub>3</sub>)<sub>2</sub>N<sub>4</sub>O<sub>2</sub>.

SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. C <sub>8</sub> H <sub>8</sub> (CH <sub>3</sub> ) <sub>2</sub> N <sub>4</sub> O <sub>2</sub> per 100 Gms. Solvent.	Authority.
Water	18	0.0305	(Paul, 1901.)
"	15-20	0.059	(Squire & Caines, 1905.)
Aq. 0.25 % HCl	18	0.047	(Paul, 1901.)
" 1 % HCl	18	0.083	"
" 0.1 % NaOH	18	1.78	"
" 0.25 % "	18	4.56	"
" 15.6 per cent Na <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub> . Sol.	15	3.69	(Brissemoret, 1898.)
92.3 Wt. % Alcohol	21	0.045	(Squire & Caines, 1905.)
90 Wt. % Alcohol	15-20	0.02	"
Dichlorethylene	15	0.005	(Wester & Bruins, 1914.)
Trichlorethylene	15	0.008	"
Carbon Tetrachloride	b. pt.	0.021;	(Göckel, 1897.)
Ether	b. pt.	0.032	"

**THIOPHENE MonoCARBONIC ACIDS**  $\alpha$ ,  $\beta$  and  $\alpha$  C<sub>4</sub>H<sub>3</sub>SCOOH.

The solubility of the three isomers is given by Voerman (1907) as 0.57 gm. of the  $\alpha$  acid per 100 cc. sat. solution at 21°; 0.445 gm. of the  $\beta$  acid at 18°, and 0.75 gm. of the  $\alpha$  acid at 17°. The solvent is not stated. Data for the solidification points of mixtures of the  $\alpha$  and  $\beta$  acid are also given.

**THEOPHYLLINE** (Theocin) C<sub>8</sub>H<sub>8</sub>(CH<sub>3</sub>)<sub>2</sub>N<sub>4</sub>O<sub>2</sub>.H<sub>2</sub>O.

100 gms. H<sub>2</sub>O dissolve 0.52 gm. theophylline at 15-20°. (Squire & Caines, 1905.)  
 100 cc. 90 vol. % alcohol dissolve 1.25 gms. theophylline at 15-20°.

**THORIUM EMANATIONS.**

Data for the solubility of thorium emanations are given by Klaus (1905).

**THORIUM ChloroACETATES.**

SOLUBILITY IN WATER AT 25°. (Karl, 1910.)

Name of Salt.	Formula.	Gms. Salt per 100 Gms. H <sub>2</sub> O.
Basic Thorium Monochloroacetate	(ClCH <sub>2</sub> COO) <sub>2</sub> Th(OH) <sub>2</sub> .H <sub>2</sub> O	0.0663
Basic Thorium Dichloroacetate	(Cl <sub>2</sub> CHCOO) <sub>2</sub> Th(OH) <sub>2</sub>	0.0887
Basic Thorium Trichloroacetate	(Cl <sub>3</sub> C.COO) <sub>2</sub> Th(OH) <sub>2</sub>	0.0091



## THORIUM BORATE

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## THORIUM BORATE.

The precipitate which results when thorium nitrate is added to a solution of borax is not a stable compound. Solubility determinations made by four successive extractions of it at 18° with water, gave the following gms. of material per 100 gms. H<sub>2</sub>O; 0.5366, 0.1250, 0.0611 and 0.0560. After the fourth extraction, the residue then contained 10.14% B<sub>2</sub>O<sub>3</sub> and after boiling 10 gms. with 100 cc. of H<sub>2</sub>O for 6 hrs. and repeating this four times, it contained 9.81% B<sub>2</sub>O<sub>3</sub>. (Karl, 1912)

## THORIUM HIPPURATE Th(C<sub>6</sub>H<sub>5</sub>CO.CH<sub>2</sub>.NH.COO).

100 gms. H<sub>2</sub>O dissolve 0.0318 gm. of the salt at 25°.

(Karl, 1912)

## THORIUM OXALATE Th(C<sub>2</sub>O<sub>4</sub>)<sub>3</sub>.6H<sub>2</sub>O.

### SOLUBILITY IN AQUEOUS SOLUTIONS OF AMMONIUM OXALATE AT 25°.

(Hauser and Wirth, 1909a, 1912.)

Gm. Mols. per 1000 Gms. Sat. Sol.		Solid Phase.	Normality of Aq. (NH <sub>4</sub> ) <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	Gms. ThO <sub>2</sub> per 1000 Gms. Sat. Sol.	Solid Phase.
(NH <sub>4</sub> ) <sub>2</sub> C <sub>2</sub> O <sub>4</sub> .	Th(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> .				
0.00033	0.00005	Th(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> .6H <sub>2</sub> O	0.01	0.040	Th(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> .6H <sub>2</sub> O
0.00072	0.00012	"	0.10	2.203	"
0.00120	0.000208	"	0.5*	7.660	[Th <sub>2</sub> (C <sub>2</sub> O <sub>4</sub> ) <sub>4</sub> ](NH <sub>4</sub> ) <sub>7</sub> .H <sub>2</sub> O
0.00153	0.00026	"	0.5*	10.63	"
0.601†	0.195	[Th(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> (NH <sub>4</sub> ) <sub>3</sub> .3H <sub>2</sub> O	0.5*	15.90	"
1.181†	0.427	"	0.5*	17.60	"
1.420†	0.540	"	0.5*	17.75	"
1.480†	0.563	"			

\* In these cases the greater part of the ammonium salt entered the solid phase complex and it was, therefore, necessary to add additional ammonium oxalate until constant results were obtained.

† In these cases the solvent was saturated ammonium oxalate solutions containing an excess of the crystals.

A thorium ammonium oxalate of the composition Th(C<sub>2</sub>O<sub>4</sub>.NH<sub>4</sub>)<sub>4</sub>.4H<sub>2</sub>O is described by Brauner (1898). It is partially hydrolytically decomposed in aqueous solution and a solubility determination made by analyzing the solution from which the nearly pure salt began to crystallize, showed that 100 gms. H<sub>2</sub>O contain 90.3 gms. Th(C<sub>2</sub>O<sub>4</sub>.NH<sub>4</sub>)<sub>4</sub>.4H<sub>2</sub>O and 9.3 gms. of (NH<sub>4</sub>)<sub>2</sub>C<sub>2</sub>O<sub>4</sub> (= an additional  $\frac{1}{2}$  mol. wt.)

### SOLUBILITY OF THORIUM OXALATE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID.

Results at 17°. (Colani, 1913.)		Results at 25°. (Hauser and Wirth, 1912.)			Results at 50°. (Colani, 1913.)	
Gms. per 100 Gms. Sat. Sol.	Th(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> .	Conc. of Aq. HCl in Per cent.	Gm. ThO <sub>2</sub> per 1000 Gms. Sat. Sol.	Solid Phase.	Gms. per 100 Gms. Sat. Sol.	Th(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> .
HCl.					HCl.	
0	0.0017	24.8	0.100	3Th(C <sub>2</sub> O <sub>4</sub> ) <sub>3</sub> .ThCl <sub>4</sub> .2H <sub>2</sub> O	0	0.0017
1.2	0.0035	37	3.450	"	4.1	0.010
3.6	0.0061	37.6	3.492	"	8.4	0.028
4.6	0.0094				12.4	0.057
8.4	0.017				16.1	0.103
13.1	0.028				18	0.134
16.2	0.038				19.9	0.169
19.8	0.064				21.6	0.232

Data are also given for the solubility of thorium oxalate in aqueous solutions of mixtures of hydrochloric and oxalic acids at the above temperatures.



**SOLUBILITY OF THORIUM CHLOROXYALATE,  $3\text{Th}(\text{C}_2\text{O}_4)_2 \cdot \text{ThCl}_4 \cdot 2\text{H}_2\text{O}$ , IN AQUEOUS HYDROCHLORIC ACID.**

(Colani, 1913.)

t°.	Gms. per 100 Gms. Sat. Sol.		t°.	Gms. per 100 Gms. Sat. Sol.	
	HCl.	$\text{Th}_4(\text{C}_2\text{O}_4)_3\text{Cl}_4$ .		HCl.	$\text{Th}_4(\text{C}_2\text{O}_4)_3\text{Cl}_4$ .
12	23	0.12	50	21.2	0.29
15	26.3	0.17	50	23	0.34
12	29.9	0.27	50	26.8	0.46
15	32.5	0.48	50	29.8	0.75
12	33.1	0.53	50	32.3	1.51
15	35	1.03	50	34.6	2.59

Results are also given showing the effect of oxalic acid upon the solubility of the above salt in aqueous hydrochloric acid.

**SOLUBILITY OF THORIUM OXALATE IN AQUEOUS OXALIC ACID SOLUTIONS.**

Results at 25°.

(Hauser and Wirth, 1912.)

Normality of Aq. $\text{H}_2\text{C}_2\text{O}_4$ .	Gms. $\text{ThO}_2$ per 1000 Gms. Sat. Sol.	Solid Phase.
I	0.0015	$\text{Th}(\text{C}_2\text{O}_4)_2 \cdot 6\text{H}_2\text{O}$
Sat. Solution	0.0030	" + $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$

Results at 50°.

(Colani, 1913.)

Gms. per 100 Gms. Sat. Sol.	
$\text{H}_2\text{C}_2\text{O}_4$ .	Th.
1.7	0.0002
9.3	0.001
23	0.003

**SOLUBILITY OF THORIUM OXALATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID AT 25°.**

(Hauser and Wirth, 1909a, 1912; Wirth, 1912.)

Normality of Aq. $\text{H}_2\text{SO}_4$ .	Gms. $\text{ThO}_2$ per 1000 Gms. Sat. Sol.	Solid Phase.	Normality of Aq. $\text{H}_2\text{SO}_4$ .	Gms. $\text{ThO}_2$ per 1000 Gms. Sat. Sol.	Solid Phase.
0.25	0.07	$\text{Th}(\text{C}_2\text{O}_4)_2 \cdot 6\text{H}_2\text{O}$	4.32	1.10	$\text{Th}(\text{C}_2\text{O}_4)_2 \cdot 6\text{H}_2\text{O}$
0.5	0.14	"	4.9	1.32	"
I	0.26	"	6.175	1.513	"
2.1	0.418	"	6.885	1.794	"
3.2	0.71	"	8.45	2.473	"

**THORIUM PICRATE  $\text{Th}(\text{C}_6\text{H}_3\text{N}_2\text{O}_7)_4 \cdot 10\text{H}_2\text{O}$ .**

100 gms.  $\text{H}_2\text{O}$  dissolve 0.3052 gm. of the salt at 25°.

(Karl, 1910.)

**THORIUM SELENATE  $\text{Th}(\text{SeO}_4)_2 \cdot 9\text{H}_2\text{O}$ .**

100 gms.  $\text{H}_2\text{O}$  dissolve 0.498 gm.  $\text{Th}(\text{SeO}_4)_2$  at 0° and 1.972 gms. at 100°.

(Cleve, 1885.)

**THORIUM SULFATE  $\text{Th}(\text{SO}_4)_2$ .**

**SOLUBILITY IN WATER.**

(Rooseboom, 1890; Demarcay, 1883.)

t°.	Gms. $\text{Th}(\text{SO}_4)_2$ per 100 Gms. $\text{H}_2\text{O}$ .		Solid Phase.	t°.	Gms. $\text{Th}(\text{SO}_4)_2$ per 100 Gms. $\text{H}_2\text{O}$ .		Solid Phase.
0	0.74 (R)	0.88 (D)	$\text{Th}(\text{SO}_4)_2 \cdot 9\text{H}_2\text{O}$	0	1.50 (R)		$\text{Th}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$
10	0.98	1.02	"	15	1.63		"
20	1.38	1.25	"	30	2.45		"
30	1.995	1.85	"	45	3.85		"
40	2.998	2.83	"	60	6.64		"
50	5.22 (51°)	4.86	"	17	9.41 (D)		$\text{Th}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$
55	6.76	6.5±	"	40	4.04 (R) 4.5 (35° D)		"
0	1.0		$\text{Th}(\text{SO}_4)_2 \cdot 8\text{H}_2\text{O}$	50	2.54	1.94 (55°)	"
15	1.38		"	60	1.63	...	"
25	1.85		"	70	1.09	1.32 (75°)	"
44	3.71		"	95	...	0.71	"

Additional results for the  $\cdot 8\text{H}_2\text{O}$  and the  $\cdot 9\text{H}_2\text{O}$  salt, in fair agreement with the above, are given by Wyruboff (1901).



## SOLUBILITY OF THORIUM SULFATE IN AQUEOUS SOLUTIONS OF:

Ammonium Sulfate at 16°.  
(Barre, 1911.)Lithium Sulfate at 25°.  
(Barre, 1912.)

Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.	Gms. per 100 Gms. H <sub>2</sub> O.	
(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .	Th(SO <sub>4</sub> ) <sub>2</sub> .		Li <sub>2</sub> SO <sub>4</sub> .	Th(SO <sub>4</sub> ) <sub>2</sub> .
2.13	3.361	Th(SO <sub>4</sub> ) <sub>2</sub> ·9H <sub>2</sub> O	0	1.722
4.80	5.269	"	2.57	4.13
10.02	8.947	"	4.93	6.20
16.56	13.330	" + 1.1.4	6.98	7.95
28	10.359	1.1.4	9.23	9.68
35.20	9.821	" + 1.2.2	11.13	11.05
45.14	6.592	1.2.2	13.18	12.54
49.05	5.750	"	16.12	14.52
52.88	4.583	1.3.3	20.49	16.02
69.74	1.653	"	25.18	18.87

1.1.4 = Th(SO<sub>4</sub>)<sub>2</sub>·(NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>·4H<sub>2</sub>O; 1.2.2 = Th(SO<sub>4</sub>)<sub>2</sub>·2(NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>·2H<sub>2</sub>O; 1.3.3 = Th(SO<sub>4</sub>)<sub>2</sub>·3(NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>·3H<sub>2</sub>O.

SOLUBILITY OF THORIUM SULFATE IN AQUEOUS SOLUTIONS OF POTASSIUM SULFATE.  
(Barre, 1911.)

Results at 16°.		Solid Phase.	Results at 75°.	
Gms. per 100 Gms. H <sub>2</sub> O.	Th(SO <sub>4</sub> ) <sub>2</sub> .		Gms. per 100 Gms. H <sub>2</sub> O.	Th(SO <sub>4</sub> ) <sub>2</sub> .
0	1.39	Th(SO <sub>4</sub> ) <sub>2</sub> ·9H <sub>2</sub> O	0	0.9248
0.424	1.667	Th(SO <sub>4</sub> ) <sub>2</sub> ·K <sub>2</sub> SO <sub>4</sub> ·4H <sub>2</sub> O	0.865	1.137
1.004	2.193	"	1.167	1.173
1.152	3.191	"	1.172	1.121
1.224	2.514	"	1.270	0.997
1.283	2.222	"	1.296	0.495
1.348	1.706	"	1.852	0.297
1.378	1.637	Th(SO <sub>4</sub> ) <sub>2</sub> ·2K <sub>2</sub> SO <sub>4</sub> ·2H <sub>2</sub> O	3.117	0.201
1.487	0.870	"	4.659	0.256
1.844	0.370	"	5.348	0.170
3.092	0.070	"	5.932	0.123
4.050	0.027	Th(SO <sub>4</sub> ) <sub>2</sub> ·3K <sub>2</sub> SO <sub>4</sub>	7.177	0.031
4.825	0.003	"	9.706	0.022

SOLUBILITY OF THORIUM SULFATE IN AQUEOUS SOLUTIONS OF HYDROCHLORIC ACID AND OF NITRIC ACID AT 30°.  
(Koppel and Holtkamp, 1910.)

In Aq. Hydrochloric Acid.			In Aq. Nitric Acid.		
Wt. % HCl in Solvent.	Gms. Th(SO <sub>4</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	Wt. % HNO <sub>3</sub> in Solvent.	Gms. Th(SO <sub>4</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.
0	2.15	Th(SO <sub>4</sub> ) <sub>2</sub> ·8H <sub>2</sub> O	0	2.15	Th(SO <sub>4</sub> ) <sub>2</sub> ·8H <sub>2</sub> O
4.55	3.541	"	5.17	3.68	"
6.95	3.431	"	10.04	4.20	"
12.14	2.811	"	16.68	4.84	"
15.71	2.360	"	21.99	4.47	"
18.33	2.199	"	28.33	3.96	"
20	2.110	Th(SO <sub>4</sub> ) <sub>2</sub> ·4H <sub>2</sub> O	28.51	3.88	"
20	2.141	"	33.17	3.34	Th(SO <sub>4</sub> ) <sub>2</sub> ·4H <sub>2</sub> O
23.9	1.277	"	38.82	2.51	"



## SOLUBILITY OF THORIUM SULFATE IN AQUEOUS SOLUTIONS OF:

## Sodium Sulfate at 16°.

(Barre, 1910, 1911.)

Gms. per 100 Gms. H <sub>2</sub> O.		Solid Phase.
Na <sub>2</sub> SO <sub>4</sub> .	Th(SO <sub>4</sub> ) <sub>2</sub> .	
1.094	1.743	Th(SO <sub>4</sub> ) <sub>2</sub> .Na <sub>2</sub> SO <sub>4</sub> .6H <sub>2</sub> O
1.960	2.387	"
2.98	3.962	"
4.11	3.375	"
5.79	2.136	"
9.35	1.379	"
12.24	1.169	"
15.36	1.048	"

## Sulfuric Acid at 25°.

(Barre, 1912.)

Gms. per 100 Gms. H <sub>2</sub> O.	
H <sub>2</sub> SO <sub>4</sub> .	Th(SO <sub>4</sub> ) <sub>2</sub> .
0	1.722
1.072	1.919
1.941	2.017
2.821	2.060
3.843	2.061
5.212	2.035
8.055	1.863
10.105	1.702

## SOLUBILITY OF THORIUM SULFATE IN AQUEOUS SOLUTIONS OF SULFURIC ACID

## Results at 25°.

(Wirth, 1912.)

Normality	Gms. Th(SO <sub>4</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.
0.504	1.593	Th(SO <sub>4</sub> ) <sub>2</sub> .9H <sub>2</sub> O	20
1	1.831	"	20
1.6	1.488	"	20
3.2	0.8751	"	20
6.8	0.4312	"	b. pt.
6.8	0.1045	Th(SO <sub>4</sub> ) <sub>2</sub> .8H <sub>2</sub> O	"
8.9	0.0636	"	"
15	0.0308	Th(SO <sub>4</sub> ) <sub>2</sub> .4H <sub>2</sub> O	"

## Results at 20° and at the b.pt.

(Koppel and Holtkamp 1910.)

Normality	Gms. Th(SO <sub>4</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Wt. % H <sub>2</sub> SO <sub>4</sub> in Solvent.	Gms. Th(SO <sub>4</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.
0.504	1.593	Th(SO <sub>4</sub> ) <sub>2</sub> .9H <sub>2</sub> O	20	5	1.722	Th(SO <sub>4</sub> ) <sub>2</sub> .8H <sub>2</sub> O
1	1.831	"	20	15	0.9752	"
1.6	1.488	"	20	25	0.3838	"
3.2	0.8751	"	20	40	0.0103	Th(SO <sub>4</sub> ) <sub>2</sub> .4H <sub>2</sub> O
6.8	0.4312	"	b. pt.	5	0.7407	Th(SO <sub>4</sub> ) <sub>2</sub> .8H <sub>2</sub> O
6.8	0.1045	Th(SO <sub>4</sub> ) <sub>2</sub> .8H <sub>2</sub> O	"	10	0.4808	"
8.9	0.0636	"	"	15	0.3882	"

## Results at 30°. (Koppel and Holtkamp, 1910.)

H <sub>2</sub> SO <sub>4</sub> in solvent.	Gms. Th(SO <sub>4</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.	Wt. % H <sub>2</sub> SO <sub>4</sub> in Solvent.	Gms. Th(SO <sub>4</sub> ) <sub>2</sub> per 100 Gms. Sat. Sol.	Solid Phase.
	2.152	Th(SO <sub>4</sub> ) <sub>2</sub> .8H <sub>2</sub> O	15.03	1.484	Th(SO <sub>4</sub> ) <sub>2</sub> .8H <sub>2</sub> O
466	2.055	"	23.64	0.7196	"
72	2.085	"	32.68	0.3364	"
468	2.267	"	37.80	0.077	Th(SO <sub>4</sub> ) <sub>2</sub> .4H <sub>2</sub> O
983	2.311	"	43.28	0.0213	"
38	2.367	"	45.69	0.0047	"
97	2.323	"	74	0.1208	"
95	1.961	"	80.5	0	"

**THORIUM m Nitrobenzene SULFONATE** Th(C<sub>6</sub>H<sub>4</sub>.NO<sub>2</sub>.SO<sub>3</sub>)<sub>2</sub>.7H<sub>2</sub>O.100 gms. H<sub>2</sub>O dissolve 61 gms. of the anhydrous salt at 15°. (Holmberg, 1907.)**THORIUM OXALATE** Tm<sub>2</sub>(C<sub>2</sub>O<sub>4</sub>)<sub>3</sub>.9H<sub>2</sub>O(?10H<sub>2</sub>O).

100 cc. aq. 20% methylamine oxalate dissolve approx. 4.082 gms. thulium oxalate.

100 cc. aq. 20% ethylamine oxalate dissolve approx. 5.728 gms. thulium oxalate.

100 cc. aq. 20% triethylamine oxalate dissolve approx. 1.340 gms. thulium oxalate.

(Grant and James, 1917.)

**THORIUM Bromonitrobenzene SULFONATE** Tm(C<sub>6</sub>H<sub>3</sub>Br.NO<sub>2</sub>.SO<sub>3</sub>.1.4.2)<sub>2</sub>.H<sub>2</sub>O.

100 gms. sat. solution in water contain 6.379 gms. of the anhydrous salt at 25°.

(Katz and James, 1913.)

**THORIUM MOL (3 Methyl 6 Isopropyl Phenol)** C<sub>11</sub>H<sub>7</sub>.C<sub>3</sub>H<sub>7</sub>.OH.CH<sub>3</sub>.

## SOLUBILITY IN WATER. (Seidell, 1912.)

Normality	Gms. Thymol per 100 Gms. Sat. Sol.	t°.	Gms. Thymol per 100 Gms. Sat. Sol.	t°.	Gms. Thymol per 100 Gms. Sat. Sol.
3	0.067	25	0.0995	37	0.132 (d <sub>20</sub> = 1)
5	0.077	30	0.112	40	0.141
5	0.088	35	0.126		



# THYMOL

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## SOLUBILITY OF THYMOL IN AQUEOUS HYDROCHLORIC ACID. (Seidell, 1912.)

Normality of Aq. HCl.	Gm. Thymol per 100 cc. Sat. Sol. at:	
	25°.	37.2°.
0	0.0995	0.132
0.1	0.0968 ( $d_{25} = 1.002$ )	0.129
0.5	0.0884 ( $d_{25} = 1.009$ )	0.121
1	0.0802 ( $d_{25} = 1.018$ )	0.112
2.5	0.0612 ( $d_{25} = 1.043$ )	0.0935
5	0.0445	0.0772 ( $d_{25} = 1.081$ )

100 cc. 90 vol. per cent alcohol dissolve about 300 gms. of thymol at 15°-20°.  
(Squire and Caines, 1905.)

## SOLUBILITY OF THYMOL IN SEVERAL OILS. (Seidell, 1912.)

t°.	Gms. Thymol per 100 Gms. of:						
	Olive Oil.	Peanut Oil.	Cod Liver Oil.	Liquid Petrolatum.	Castor Oil.	Cottonseed Oil.	Linseed Oil.
10	46.2	73	50	3.1	81.2	56.2	62.3
15	50.1	73.8	52	3.95	90.2	64	63.1
20	56.2	74.6	55.5	5.6	101.5	74.2	65.1
25	66.9	76.4	63.1	9.78	116.5	89.4	69
30	84.5	83.2	77	16.3	137	113.7	78.3
35	111	106.7	102	25.5	165	146.5	100
37	124.3	130.5	116.5	29.9	180	166.5	116.5
40	151.9	212.5	150	38.9	213	217.5	152

The specific gravities of the above saturated solutions and of solutions of lower concentrations of thymol in the several oils are also given.

## DISTRIBUTION OF THYMOL BETWEEN WATER AND OILS AT 25° AND AT 37°. (Seidell, 1912.)

t°.	Water + Olive Oil.			Water + Cod Liver Oil.			Water + Peanut Oil.		
	Gms. Thymol per 100 cc.			Gms. Thymol per 100 cc.			Gms. Thymol per 100 cc.		
	Oil Layer (c <sub>o</sub> ).	H <sub>2</sub> O Layer (c <sub>w</sub> ).	c <sub>w</sub> .	Oil Layer (c <sub>o</sub> ).	H <sub>2</sub> O Layer (c <sub>w</sub> ).	c <sub>w</sub> .	Oil Layer (c <sub>o</sub> ).	H <sub>2</sub> O Layer (c <sub>w</sub> ).	c <sub>w</sub> .
25	0.1014	44.95	443	0.1079	49	454	0.1077	46.48	31
25	0.0848	36.34	428	0.0816	32.58	400	0.0786	32.45	13
25	0.0349	16.26	465	0.0371	16.18	436	0.0395	16.16	4
25	0.0106	4.54	430	0.0127	4.57	359	0.0088(?)	4.63	5
37	0.1087	46.35	427	0.1009	43.81	399			
37	0.0807	33.48	415	0.0862	32.90	380			
37	0.0381	16.24	426	0.0574	22.51	392			
37	0.0122	4.61	378	0.0250	8.86	357			

Freezing-point data for mixtures of thymol and sulfuric acid are given by Kendall and Carpenter (1914).

Results for thymol + bromotoluene are given by Paterno and Ampola (1897).

# TIN Sn.

## DISTRIBUTION OF TIN BETWEEN AQUEOUS HYDROCHLORIC ACID AND ETHER AT ROOM TEMPERATURE. (Mylius, 1911.)

When 1 gm. of tin as the chloride, SnCl<sub>4</sub>, is dissolved in 100 cc. of aqueous hydrochloric acid and shaken with 100 cc. of ether, the following per cents of the metal enter the ethereal layers. With 20% HCl, 17 per cent; with 15% HCl, 28 per cent; with 10% HCl, 23 per cent; with 5% HCl, 10 per cent and with 1% HCl, 0.8 per cent of the tin.



**TIN CHLORIDE** (Stannous)  $\text{SnCl}_2$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 83.9 gms.  $\text{SnCl}_2$  at  $0^\circ$  and 269.8 gms. at  $15^\circ$ . Sp. Gr. Solutions 1.532 and 1.827 respectively. (Engel, 1889; Michel and Krafft, 1851.)

SOLUBILITY OF STANNOUS CHLORIDE IN AQUEOUS SOLUTIONS OF  
HYDROCHLORIC ACID AT  $0^\circ$ .

(Engel.)

Milligram Mols. per 10 cc. Solution.		Sp. Gr. of Solution.	Grams per 100 cc. Solution.	
HCl.	$\frac{1}{2}\text{SnCl}_2$		HCl.	$\text{SnCl}_2$
0	74.0	1.532	0.0	70.26
6.6	66.7	1.489	2.405	63.33
13.54	63.75	1.472	4.935	60.52
24.8	68.4	1.524	9.04	64.95
34.9	81.2	1.625	12.72	77.11
40.0	94.2	1.724	14.58	89.45
44.0	117.6	1.883	16.04	111.7
49.4	147.6	2.114	18.01	138.6
66.0	156.4	2.190	24.05	148.5
78.0	157.0	2.199	28.43	149.0

100 gms. acetone dissolve 55.6 gms.  $\text{SnCl}_2$  at  $18^\circ$ . ( $d_{18} = 1.6$ .) (Naumann, 1904.)

100 gms. ether dissolve 11.4 gms.  $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$  at  $0^\circ$ – $35.5^\circ$ .

100 gms. ethyl acetate dissolve 31.2 gms.  $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$  at  $-2^\circ$ , 35.53 gms. at  $-22^\circ$  and 73.44 gms. at  $82^\circ$ . (von Laszynski, 1894.)

100 gms. ethyl acetate dissolve 4.46 gms.  $\text{SnCl}_2$  at  $18^\circ$ .  $d_{18}$  of the sat. solution = 0.9215. (Naumann, 1910.)

100 gms. 95 per cent formic acid dissolve 4.1 gms.  $\text{SnCl}_2$  at  $19^\circ$ . (Aschan, 1913.)

Freezing-point data for mixtures of  $\text{SnCl}_2 + \text{ZnCl}_2$  are given by Herrmann (1911).

**TIN CHLORIDE** (Stannic)  $\text{SnCl}_4$ .

## DISTRIBUTION OF STANNIC CHLORIDE BETWEEN WATER AND XYLENE.

(Smirnov, 1907.)

Very concentrated aqueous stannic chloride solutions were agitated with xylene at various temperatures and the amount of  $\text{SnCl}_4$ , in terms of Cl, which entered the xylene layer was determined. The amount of Sn and Cl in the xylene was found to correspond to  $\text{SnCl}_4$ .

Results for Xylene +  $\text{SnCl}_4 \cdot 5\text{H}_2\text{O}$ .

t°.	Gms. Cl per 100 Gms.		$\frac{c}{c'}$
	Aq. Layer, c.	Xylene Layer, c'.	
66	40.35	0.08	504.4
80	39.95	0.18	228.5
97.5	40.24	0.33	122.1
111	40.27	0.68	59.3

Per cent Cl in  $\text{SnCl}_4 \cdot 5\text{H}_2\text{O} = 40.38$ .Results for Xylene +  $\text{SnCl}_4 \cdot 4\text{H}_2\text{O}$ .

t°.	Gms. Cl per 100 Gms.		$\frac{c}{c'}$
	Aq. Layer, c.	Xylene Layer, c'.	
66	41.9	0.92	45.3
80	41.91	1.56	27
100	41.85	2.52	16.7
111	41.68	3.23	12.9

Per cent Cl in  $\text{SnCl}_4 \cdot 4\text{H}_2\text{O} = 42.37$ .Results for Xylene +  $\text{SnCl}_4 \cdot 3\text{H}_2\text{O}$ .

t°.	Gms. Cl per 100 Gms.		$\frac{c}{c'}$
	Aq. Layer, c.	Xylene Layer, c'.	
80	43.2	9.93	4.4
94	42.54	9.32	4.6
100	42.64	10.56	4.1
111	42.31	10.03	4.2

Per cent Cl in  $\text{SnCl}_4 \cdot 3\text{H}_2\text{O} = 45.12$ .



# TIN HYDROXIDE

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## TIN HYDROXIDE (Stannous) $\text{Sn}(\text{OH})_2$ .

One liter of the saturated solution in water contains 0.0000135 gm. mols.  $\text{Sn}(\text{OH})_2$  at 25°. (Goldschmidt and Eckhardt, 1906.)

### SOLUBILITY OF STANNOUS HYDROXIDE IN AQUEOUS SODIUM HYDROXIDE SOLUTIONS AT 25°.

(Goldschmidt and Eckhardt, 1906.)

The authors desired to ascertain whether the mono,  $\text{NaHSnO}_3$ , or the disodium salt,  $\text{Na}_2\text{SnO}_3$ , predominates in alkaline tin hydroxide solutions. Given amounts of carefully prepared tin chloride, made from tin and  $\text{HCl}$ , and sodium hydroxide solutions were mixed in vessels containing hydrogen. The mixtures were shaken at 25° and the clear supernatant solutions in contact with the precipitated  $\text{Sn}(\text{OH})_2$ , analyzed.

Gm. Mols. per Liter.			Gm. Mols. per Liter.		
Total Na.	$\text{NaHSnO}_3$ .	$\text{NaOH}$ .	Total Na.	$\text{NaHSnO}_3$ .	$\text{NaOH}$ .
0.00451	0.0009845	0.003525	0.02250	0.00838	0.01412
0.00680	0.00218	0.00462	0.02788	0.01038	0.01755
0.01149	0.003495	0.007995	0.02940	0.00874	0.02066
0.02143	0.006935	0.014495	0.03012	0.00865	0.02147
0.02143	0.00660	0.01483	0.03036	0.01082	0.01954
0.02186	0.00628	0.015575	0.03044	0.009405	0.021035

### SOLUBILITY IN AQUEOUS SODIUM HYDROXIDE SOLUTIONS. MOIST TIN HYDROXIDE USED. ORDINARY TEMPERATURE.

(Rubenbauer, 1902.)

Gms. per 20 cc. Solution.		Mol. Dilution of the $\text{NaOH}$ .	Gms. per 20 cc. Solution.		Mol. Dilution of the $\text{NaOH}$ .
Na.	Sn.		Na.	Sn.	
0.2480	0.1904	1.86	0.8326	0.5560	0.55
0.3680	0.2614	1.25	0.9661	0.7849	0.48
0.6394	0.4304	0.72	2.1234	1.8934	0.23

## TIN IODIDE (Stannous) $\text{SnI}_2$ .

### SOLUBILITY IN WATER AND IN AQUEOUS HYDRIODIC ACID.

(Young, 1897.)

t°.	Gms. $\text{SnI}_2$ per 100 Gms. Aqueous HI Solutions of:							
	0% = $\text{H}_2\text{O}$ .	5.83%.	9.60%.	15.2%.	20.44%.	24.85%.	30.4%.	36.82%.
20	0.98	0.20	0.23	0.60	1.81	4.20	10.86	25.31
30	1.16	0.23	0.23	0.64	1.81	4.06	10.28	23.46
40	1.40	0.33	0.28	0.71	1.90	4.12	10.06	23.15
50	1.69	0.46	0.38	0.82	2.12	4.34	10.35	23.76
60	2.07	0.66	0.55	1.11	2.51	4.78	11.03	24.64
70	2.48	0.91	0.80	1.37	2.92	5.43	11.97	25.72
80	2.95	1.23	1.13	1.83	3.70	6.38	13.30	27.23
90	3.46	1.65	1.52	2.40	4.58	7.82	15.52	29.84
100	4.03	2.23	2.04	3.63	5.82	9.60	...	34.05

## TIN IODIDE (Stannic) $\text{SnI}_4$ .

### SOLUBILITY IN ORGANIC SOLVENTS.

(McDermott, 1911.)

Solvent.	t°.	Sp. Gr. Sat. Sol.	Gms. $\text{SnI}_4$ per 100 Gms. Sat. Sol.
Carbon Tetrachloride	22.4	1.59	5.25
"	50	1.63	12.50
Chloroform	28	1.50	8.21
Benzene	20.2	0.95	12.65



## SOLUBILITY OF STANNIC IODIDE IN CARBON DISULFIDE.

(Sneider, 1866; Arctowski, 1893-'96.)

	-114°.5.	-94°.	-89°.	-84°.	-58°.	Ord. temp.
ns. $\text{SnI}_4$ per 100 Gms.						
Solution	9.41	10.65	9.68	10.22	16.27	59.2(S)
100 gms. methylene iodide, $\text{CH}_2\text{I}_2$ , dissolve 22.9 gms. $\text{SnI}_4$ at 10°.	Sp. Gr. of ution = 3.481.					

**N OXALATE** (Stannous)  $\text{Sn}(\text{COO})_2$ .100 gms. 95 per cent formic acid dissolve 0.16 gm.  $\text{Sn}(\text{COO})_2$  at 19°. (Aschan, 1913.)**N TetraPHENYL** (Stannic)  $\text{Sn}(\text{C}_6\text{H}_5)_4$ .Freezing-point data for  $\text{Sn}(\text{C}_6\text{H}_5)_4 + \text{Si}(\text{C}_6\text{H}_5)_4$  are given by Pascal (1912).**N SULFATE** (Stannous)  $\text{SnSO}_4$ .100 gms.  $\text{H}_2\text{O}$  dissolve 18.8 gms.  $\text{SnSO}_4$  at 19° and 18.1 gms. at 100°. (Marignac.)**OLUENE**  $\text{C}_6\text{H}_5\text{CH}_3$ .

## SOLUBILITY IN SULFUR.

Figures read from curve, synthetic method used, see Note, page 16. (Alexejew, 1886.)

t°.	Gms. $\text{C}_6\text{H}_5\text{CH}_3$ per 100 Gms.		t°.	Gms. $\text{C}_6\text{H}_5\text{CH}_3$ per 100 Gms.	
	S Layer.	Toluene Layer.		S Layer.	Toluene Layer.
100	3	73	150	12.5	59
110	4	71	160	16	53
120	5	68	170	22	47
130	7	66	175	25	43
140	9.5	63	178 crit. temp.		34

**OTOLUENE**  $\text{C}_6\text{H}_4\text{CH}_3\text{NO}_2$ .RECIPROCAL SOLUBILITY OF *o* NITROTOLUENE AND WATER.

(Campetti and Delgrosso, 1913.)

The original results were plotted and the following figures read from the curve.

t°.	Gms. <i>o</i> Nitrotoluene per 100 Gms.		t°.	Gms. <i>o</i> Nitrotoluene per 100 Gms.	
	$\text{H}_2\text{O}$ Rich Layer.	Nitrotoluene Rich Layer.		$\text{H}_2\text{O}$ Rich Layer.	Nitrotoluene Rich Layer.
150	1	98	245	13	81
175	1.5	96	250	16	78
200	3	93	255	20	72
225	6.5	89	260	29	63
240	10.5	84	263.5 crit. t.		43

100 gms. 95 per cent formic acid dissolve 13.25 gms. *p*  $\text{C}_6\text{H}_4\text{CH}_3\text{NO}_2$  at 20.8°. (Aschan, 1913.)**INITROTOLUENE** 2,4,6  $\text{C}_6\text{H}_3\text{CH}_3(\text{NO}_2)_3$ .100 gms.  $\text{H}_2\text{O}$  dissolve 0.021 gm.  $\text{C}_6\text{H}_3\text{CH}_3(\text{NO}_2)_3$  at 15° and 0.164 gm. at 100°.100 gms. alcohol dissolve 1.6 gms.  $\text{C}_6\text{H}_3\text{CH}_3(\text{NO}_2)_3$  at 22° and 10 gms. at 58°. (Capisarov, 1915.)**OLUENE SULFONAMINES** *o*, *m* and *p*.

SOLUBILITY OF EACH IN WATER AT 25°. (Holleman and Caland (1911.)

Compound.					Gms. Comp'd per Liter Sat. Sol.
Amine of <i>o</i>	Toluene	Sulfonic	Acid		1.624
" "	"	"	"	"	7.812
" "	"	"	"	"	3.156



**FREEZING-POINT DATA** (Solubility, see footnote, p. 1), FOR MIXTURES OF SUBSTITUTED TOLUENES AND OTHER COMPOUNDS.

Mixture.	Authority.
<i>o</i> Bromotoluene + <i>p</i> Bromotoluene	(van der Laan, 1907.)
Bromotoluene + <i>p</i> Xylene	(Paterno and Ampola, 1897.)
" + Veratrol	" "
" + Tribenzylamine	" "
<i>p</i> Nitrotoluene + $\alpha$ Ortho Nitrotoluene	(Holleman, 1914.)
" + $\beta$ " "	" "
" + 2, 4 Dinitrotoluene	(Giua, 1914, 1915.)
" + 2, 6 " "	(Giua, 1915.)
" + 2, 4, 6 " "	" "
" + <i>m</i> Nitrotoluene	(Holleman and van den Arend, 1909.)
" + Urethan	(Mascarelli, 1908, 1909.)
2, 4 Dinitrotoluene + 2, 6 Dinitrotoluene	(Giua, 1914, 1915.)
" + 2, 4, 6 Trinitrotoluene	(Giua, 1915.)
2, 6 " + " "	(Giua, 1914, 1915.)
$\alpha$ Trinitrotoluene + <i>p</i> Amino Acetophenone	(Giua, 1916.)
" + $\gamma$ Trinitrotoluene	(Giua, 1915.)
<i>o</i> Toluene Sulfochloride + <i>p</i> Toluene Sulfochloride	(Holleman and Caland, 1911.)
Binary Mixtures of Isomeric Tribromotoluenes	(Jaeger, 1904.)
" " " " Chloronitrotoluenes	(Wibaut, 1913; Holleman and van d' <sup>d</sup> Arend, 1909.)

**TOLUIC ACIDS** (Monomethyl Benzoic Acids)  $\text{CH}_3\text{C}_6\text{H}_4\text{COOH}$ .

SOLUBILITY IN WATER AT 25°.

(Paul, 1894.)

Acid.	$\text{CH}_3\text{C}_6\text{H}_4\text{COOH}$ per Liter Solution.	
	Grams.	Millimols.
Meta Toluic Acid	0.9801	7.207
Ortho Toluic Acid	1.1816	8.683
Para Toluic Acid	0.3454	2.540

One liter sat. solution in water contains 0.42 gram *p* toluic acid at 25°. One l sat. solution in 1 *N* aq. sodium *p* toluate contains 0.735 gm. *p* toluic acid at : (Sidgwick, 1915.)

SOLUBILITY OF TOLUIC ACIDS (EACH SEPARATELY) IN WATER AT VARIOUS TEMPERATURES.

(Sidgwick, Spurrell and Davies, 1915.)

The determinations were made by the synthetic method, see p. 16; melt point of *o* toluic acid = 102.4°, of *m* acid = 110.5° and of *p* acid = 176.8°. triple point (solid phase present) for the *o* acid, is at 93.5° and the concentra of acid in the two layers is 2.5 and 91.2 gms. respectively per 100 gms. sat. s tion. The tr. pt. for the *m* acid is at 91.8° and concentrations are 1.6 and 9 the tr.-pt. for the *p* acid is at 142° and concentrations, 5 and 74.

t°.	Gms. per 100 Gms. Sat. Sol.			t°.	Gms. per 100 Gms. Sat. Sol.		
	<i>o</i> Toluic Acid.	<i>m</i> Toluic Acid.	<i>p</i> Toluic Acid.		<i>o</i> Toluic Acid.	<i>m</i> Toluic Acid.	<i>p</i> Toluic Acid.
80	2.03*	1.16*	...	140	9.25	5.77	4.3
90	2.42*	1.54	...	150	13.7	8.40	9.3
100	2.97	1.98	1.16*	159.1 crit. t.	...	...	∞
110	3.71	2.52	1.36*	160	30	19.4	...
120	5.10	3.24	1.75*	161.1 crit. t.	∞	...	...
130	6.93	4.30	2.50*	162.2 crit. t.	...	∞	...

\* Indicates that a solid phase is present.

Additional data for the solubility of the above compounds in water, determi by the synthetic method, are given by Flaschner and Rankin (1910).



TABLE OF THE SOLUBILITIES OF TOLUIC ACIDS (SEPARATELY DETERMINED)  
IN WATER AND IN OLIVE OIL AT 25°.

(Boeseken and Waterman, 1911, 1912.)

The solubilities of each acid in water and in olive oil was separately determined and the ratio considered to correspond to the distribution coefficients in each case. The concentrations of the dissolved acids are not given.

Acid.	Ratio of Solubility in Olive Oil Solubility in Water
<i>o</i> Toluic Acid	40.5
<i>m</i> " "	21
<i>p</i> " "	29.5

100 gms. 95% formic acid dissolve 2.99 gms. *o* toluic acid at 20.8°. (Aschan, 1913.) Freezing-point data for mixtures of *o*, *m*, *p* and  $\alpha$  toluic acids (each separately) and sulfuric acid are given by Kendall and Carpenter (1914). Results for mixtures of *o*, *m* and  $\alpha$  acids and picric acid are given by Kendall (1916).

**TOLUIDINE**  $C_6H_4CH_2NH_2$ .

SOLUBILITY IN WATER.

(Vaubel, 1895; Lowenherz, 1898.)

t°.	Gms. $C_6H_4CH_2NH_2$ per 1000 Gms. $H_2O$ .	Solid Phase.	t°.	Gms. $C_6H_4CH_2NH_2$ per 1000 Gms. $H_2O$ .	Solid Phase.
20	16.26	Liquid ortho T.	20.8	7.39	Para T.
20	0.15	Ortho T.	26.7	9.50	"
20	6.54	Para T.	31.7	11.42	"

One liter sat. solution in water contains 15 gms. *o* toluidine at 25°.

One liter sat. solution in 1 *N* aq. *o* toluidine hydrochloride, contains 30 gms. toluidine at 25°. (Sidgwick, 1910.)

The following results for *p* toluidine, differing considerably from the above, are given by Walker (1890).

t°.	22°	30°	36.7°	44°	57.5°	69°
Gms. <i>p</i> Toluidine per 100 Gms. Sat. Sol. in Water	19.6	26.9	35.4	44.5	51.4	58.9

SOLUBILITY OF PARA TOLUIDINE IN ETHYL ALCOHOL.

(Interpolated from original results of Speyers, 1902.)

t°.	Wt. of 1 cc. Solution.	Mols. per 100 Mols. $C_2H_5OH$ .	Gms. per 100 Gms. $C_2H_5OH$ .	t°.	Wt. of 1 cc. Solution.	Mols. per 100 Mols. $C_2H_5OH$ .	Gms. per 100 Gms. $C_2H_5OH$ .
0	0.8885	20.72	48.1	20	0.9265	47.0	110.0
5	0.8982	26.0	60.0	25	0.9360	56.0	132.0
10	0.9080	32.0	74.0	30	0.9460	66.0	156.0
15	0.9180	38.6	90.0				

100 gms. pyridine dissolve 126 gms. *p* toluidine at 20°–25°. (Dehn, 1917.)

100 gms. aq. 50% pyridine dissolve 96.1 gms. *p* toluidine at 20°–25°. "

DISTRIBUTION OF PARA TOLUIDINE BETWEEN WATER AND CARBON  
TETRACHLORIDE.

(Vaubel, 1903.)

mm. <i>p</i> Toluidine Used.	Volumes of Solvents.	Gms. $C_6H_4(CH_2)NH_2$ <i>p</i> in:	
		$H_2O$ Layer.	$CCl_4$ Layer.
1	200 cc. $H_2O$ +100 cc. $CCl_4$	0.1406	0.8594
1	200 cc. $H_2O$ +200 cc. $CCl_4$	0.0666	0.9334



SOLUBILITY OF URANYL AMMONIUM CHLORIDE, U. TETRA METHYL AMMONIUM CHLORIDE, U. TETRA ETHYL AMMONIUM CHLORIDE, U. CAESIUM CHLORIDE, U. RUBIDIUM CHLORIDE, AND U. POTASSIUM CHLORIDE IN WATER.

(Rimbach, 1904.)

Formula of Double Salt.	t°.	Gms. per 100 Gms. Sat. Sol.	Atomic Relation in Sol.	Solid Phase.
$\text{UO}_2\text{Cl}_2 \cdot 2\text{NH}_4\text{Cl} \cdot 2\text{H}_2\text{O}$	15	40.67 $\text{UO}_2 + 3.51\text{NH}_4 + 19.15\text{Cl}$	$1\text{UO}_2 : 1.59\text{NH}_4 : 3.59\text{Cl}$	1 Mol. double salt + 0.4 Mol. $\text{NH}_4\text{Cl}$
$\text{UO}_2\text{Cl}_2 \cdot 2\text{N}(\text{C}_2\text{H}_5)_4\text{Cl}$	29.8	19.85 "	$1\text{UO}_2 : 4.02\text{Cl}$	Double salt
	80.7	20.23 "	$1\text{UO}_2 : 3.98\text{Cl}$	"
$\text{UO}_2\text{Cl}_2 \cdot 2\text{N}(\text{C}_2\text{H}_5)_3\text{Cl}$	27.1	15.02 "	$1\text{UO}_2 : 3.97\text{Cl}$	"
	80.7	15.12 "	$1\text{UO}_2 : 3.94\text{Cl}$	"
$\text{UO}_2\text{Cl}_2 \cdot 2\text{CsCl}$	29.75	22.11 "	$1\text{UO}_2 : 2.07\text{Cs}$	"
$\text{UO}_2\text{Cl}_2 \cdot 2\text{RbCl} \cdot 2\text{H}_2\text{O}$	24.8	27.18 "	$1\text{UO}_2 : 1.96\text{Rb} : 3.90\text{Cl}$	"
	80.3	30.66 "	$1\text{UO}_2 : 1.98\text{Rb} : 3.95\text{Cl}$	"
$\text{UO}_2\text{Cl}_2 \cdot 2\text{KCl} \cdot 2\text{H}_2\text{O}$	0.8	38.57 "	$1\text{UO}_2 : 2.69\text{Cl} : 0.69\text{K}$	"
"	14.9	33.71 "	$1\text{UO}_2 : 3.06\text{Cl} : 0.66\text{K}$	The double salt is decomposed by water at
"	17.5	37.36 "	$1\text{UO}_2 : 2.96\text{Cl} : 0.96\text{K}$	temperatures below 60°.
"	25	35.01 "	$1\text{UO}_2 : 3.33\text{Cl} : 1.33\text{K}$	"
"	41.5	35.27 "	$1\text{UO}_2 : 3.44\text{Cl} : 1.44\text{K}$	"
"	50	34.18 "	$1\text{UO}_2 : 3.71\text{Cl} : 1.71\text{K}$	"
"	60	34.19 "	$1\text{UO}_2 : 3.85\text{Cl} : 1.85\text{K}$	"
"	71.5	33.53 "	$1\text{UO}_2 : 3.96\text{Cl} : 1.96\text{K}$	Double salt
"	78.5	35.26 "	$1\text{UO}_2 : 3.95\text{Cl} : 1.95\text{K}$	"

$\text{UO}_2\text{Cl}_2 \cdot 2\text{N}(\text{C}_2\text{H}_5)_4\text{Cl}$       $\text{UO}_2\text{Cl}_2 \cdot 2\text{N}(\text{C}_2\text{H}_5)_3\text{Cl}$       $\text{UO}_2\text{Cl}_2 \cdot 2\text{CsCl}$   
 § = 57.9 gms.     || = 65.8 gms.      $\text{UO}_2\text{Cl}_2 \cdot 2\text{RbCl}$

URANYL Sodium CHROMATE  $2(\text{UO}_2)_2\text{CrO}_4 \cdot \text{Na}_2\text{CrO}_4 \cdot 10\text{H}_2\text{O}$ .

100 gms. sat. aqueous solution contain 52.52 gms.  $2(\text{UO}_2)_2\text{CrO}_4 \cdot \text{Na}_2\text{CrO}_4$  at 20° (Rimbach, 1904.)

URANYL IODATE  $\text{UO}_2(\text{IO}_3)_2$ .

SOLUBILITY OF THE DIFFERENT CRYSTALLINE FORMS IN WATER AT 18° (Artmann, 1912-13.)

	Appearance of Crystals.	Gms. $\text{UO}_2(\text{IO}_3)_2$ per 100 Gms. $\text{H}_2\text{O}$
$\text{UO}_2(\text{IO}_3)_2 \cdot \text{H}_2\text{O}$	Type I warty, later prismatic needles	0.1049
"	Type II pyramids, sphenoids	0.1214
$\text{UO}_2(\text{IO}_3)_2 \cdot 2\text{H}_2\text{O}$		0.2044

URANYL NITRATE  $\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ .

SOLUBILITY IN WATER.  
(Wasilieff, 1910.)

t°.	Gms. $\text{UO}_2(\text{NO}_3)_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{UO}_2(\text{NO}_3)_2$ per 100 Gms. Sat. Sol.	Solid Phase.
- 1.6	10.83	Ice	- 2.2	48.77	$\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
- 2.1	12.24	"	0	49.46	"
- 2.9	17.19	"	5.5	50.55	"
- 4.4	23.52	"	12.3	52.88	"
- 6	26.20	"	21.1	55.98	"
- 7.9	32.53	"	25.6	57.17	"
- 11.2	37.09	"	36.7	61.27	"
- 18.1	43.12	" + $\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	45.2	65.12	"
- 12.1	45.53	$\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	51.8	67.76	"

100 gms. abs. acetone dissolve 1.5 gms.  $\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  at 12° (de Coninck, 1900)

100 gms. 85% alcohol dissolve 3.3 gms.  $\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  at 12°.

Data for the densities of uranyl nitrate solutions in water and other solvent are given by de Coninck (1900).



SOLUBILITY OF URANYL NITRATE IN ETHER.  
(Lebeau, 1911.)

When a large excess of uranyl nitrate is shaken with ether at 7°, two liquid layers are formed. The ethereal layer contains 59 gms.  $\text{UO}_2(\text{NO}_3)_2$  per 100 gms. of solution and the aqueous layer contains 62.5 gms. per 100 gms. of solution. An elevation of temperature was noted when ether and  $\text{UO}_2(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  were mixed at room temperature, therefore, indicating that solution is accompanied by combination and elimination of the water of the salt.

**URANYL DOUBLE NITRATES.**

SOLUBILITY OF URANYL AMMONIUM NITRATE + URANYL NITRATE; U. CAESIUM NITRATE + CAESIUM NITRATE; U. POTASSIUM NITRATE + POTASSIUM NITRATE AND U. RUBIDIUM NITRATE + RUBIDIUM NITRATE IN WATER.  
(Rimbach, 1904.)

Formula of Salt.	t°.	Gms. per 100 Gms. Sat. Solution.		Atomic Relation in Solution.
		$\text{UO}_2$ .	Total Salt.	
$\text{UO}_2(\text{NO}_3)_2 \cdot \text{NH}_4\text{NO}_3$	0.5	29.71 + 2.92 $\text{NH}_4$	= ...	1 $\text{UO}_2$ : 1.47 $\text{NH}_4$ : 3.47 $\text{NO}_3$
"	24.9	36.46 + 3.54 "	= 68.95	" : 1.46 " : 3.46 "
"	59	44.37 + 2.90 "	= ...	" : 0.98 " : 2.98 "
"	80.7	44.95 + 2.98 "	= 78.95	" : 1 " : 3 "
$\text{UO}_2(\text{NO}_3)_2 \cdot \text{CsNO}_3$	16	31.39 + 6.59 Cs	= 55.4	" : 0.44 Cs
$\text{UO}_2(\text{NO}_3)_2 \cdot \text{KNO}_3$	0.5	31.98 + 1.72 K	= ...	" : 2.37 $\text{NO}_3$ : 0.37 K
"	13	33.40 + 2.72 "	= ...	" : 2.57 " : 0.57 "
"	25	37.07 + 4.01 " *	= 64.82	" : 1.60 " : 0.76 "
"	45	42.18 + 5.16 "	= ...	" : 2.84 " : 0.84 "
"	59	41.65 + 6.03 "	= ...	" : 3 " : 1 "
"	80.6	43.71 + 6.38 "	= 80.1	" : 3.01 " : 1.01 "
$\text{UO}_2(\text{NO}_3)_2 \cdot \text{RbNO}_3$	25	35.41 + 4.65 $\text{Rb}^\dagger$	= 59.60	" : 1.40 " : 0.45 $\text{Rb}$
"	80	34.66 + 11.01 "	= 69.49	" : 3 " : 1.01 "

\* + 23.5  $\text{NO}_3$ .

† + 19.74  $\text{NO}_3$ .

**URANYL OXALATE**  $\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 0.7401 gm.  $\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$  at 25°. (Dittrich, 1899.)

EQUILIBRIUM IN THE SYSTEM URANYL OXALATE, AMMONIUM OXALATE  
AND WATER.  
(Colani, 1917.)

Results at 15°.			Results at 50°.		
Gms. per 100 Gms. Sat. Solution.	Solid Phase.		Gms. per 100 Gms. Sat. Solution.	Solid Phase.	
$\text{UO}_2\text{C}_2\text{O}_4 \cdot (\text{NH}_4)_2\text{C}_2\text{O}_4$ .			$\text{UO}_2\text{C}_2\text{O}_4 \cdot (\text{NH}_4)_2\text{C}_2\text{O}_4$ .		
0.47	0	$\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$	1	0	$\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$
7.19	2.14	" + $(\text{NH}_4)_2(\text{UO}_2)(\text{C}_2\text{O}_4)_2 \cdot 3\text{H}_2\text{O}$	5.11	1.36	" + $(\text{NH}_4)_2(\text{UO}_2)(\text{C}_2\text{O}_4)_2$
8.78	2.99	$(\text{NH}_4)_2(\text{UO}_2)(\text{C}_2\text{O}_4)_2 \cdot 3\text{H}_2\text{O}$ + "	19.89	8.52	$(\text{NH}_4)_2(\text{UO}_2)(\text{C}_2\text{O}_4)_2$ + "
9.66	6.43	" + $(\text{NH}_4)_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$	23.82	15.90	" + $(\text{NH}_4)_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$
0	3.69	$(\text{NH}_4)_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$	0	9.36	$(\text{NH}_4)_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$

Two determinations at 75° are also given.

EQUILIBRIUM IN THE SYSTEM URANYL OXALATE, POTASSIUM OXALATE  
AND WATER.  
(Colani, 1916a.)

Results at 15°.			Results at 50°.		
Gms. per 100 Gms. Sat. Solution.	Solid Phase.		Gms. per 100 Gms. Sat. Solution.	Solid Phase.	
$\text{UO}_2\text{C}_2\text{O}_4 \cdot \text{K}_2\text{C}_2\text{O}_4$ .			$\text{UO}_2\text{P}_2\text{O}_7 \cdot \text{K}_2\text{C}_2\text{O}_4$ .		
0.47	0	$\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$	1	0	$\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$
1.34	0.42	" + $\text{K}_2(\text{UO}_2)(\text{C}_2\text{O}_4)_2 \cdot 4\text{H}_2\text{O}$	3.45	1.11	" + $\text{K}_2(\text{UO}_2)(\text{C}_2\text{O}_4)_2 \cdot 4\text{H}_2\text{O}$
3.89	1.83	$\text{K}_2(\text{UO}_2)(\text{C}_2\text{O}_4)_2 \cdot 3\frac{1}{2}\text{H}_2\text{O}$ + "	9.82	4.83	$\text{K}_2(\text{UO}_2)(\text{C}_2\text{O}_4)_2$ + "
3.76	1.85	" + $\text{K}_2(\text{UO}_2)(\text{C}_2\text{O}_4)_2 \cdot 10\text{H}_2\text{O}$	9.59	5.61	" + $\text{K}_2(\text{UO}_2)(\text{C}_2\text{O}_4)_2 \cdot 10\text{H}_2\text{O}$
0.10	24.30	$\text{K}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$ + "	1.22	32.65	$\text{K}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$ + "
0	24.09	$\text{K}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$	0	32.75	$\text{K}_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$



# URANYL OXALATE

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## SOLUBILITY OF URANYL OXALATE IN AQUEOUS SODIUM OXALATE AT 25°.

(Dittrich, 1899.)

Gms. $\text{Na}_2\text{C}_2\text{O}_4$ per 100 cc. Solution.	Gms. $\text{UO}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$ per 100 cc. Sat. Solution.
0.6706	2.0125
0.3353	0.9867
0.2235	0.6059

# URANYL Ammonium PROPIONATE $2\text{UO}_2(\text{C}_2\text{H}_5\text{O}_2)_2 \cdot \text{NH}_4\text{C}_2\text{H}_5\text{O}_2 \cdot 2\text{H}_2\text{O}$ .

# URANYL Potassium PROPIONATE $\text{UO}_2(\text{C}_2\text{H}_5\text{O}_2)_2 \cdot \text{KC}_2\text{H}_5\text{O}_2$ .

100 gms. aq. solution contain 16.48 gms.  $2\text{UO}_2(\text{C}_2\text{H}_5\text{O}_2)_2 \cdot \text{NH}_4\text{C}_2\text{H}_5\text{O}_2$  at 29.8°.  
100 gms. aq. solution contain 2.362 gms.  $\text{UO}_2(\text{C}_2\text{H}_5\text{O}_2)_2 + 0.82$  gm.  $\text{KC}_2\text{H}_5\text{O}_2$   
at 29.4°, atomic relation, 1:1.29. (Rimbach, 1904)

# URANYL SULFATE $\text{UO}_2\text{SO}_4 \cdot 3\text{H}_2\text{O}$ .

## SOLUBILITY IN SEVERAL SOLVENTS.

(de Coninck, 1901, 1903.)

Solvent	t°.	Gms. $\text{UO}_2\text{SO}_4 \cdot 3\text{H}_2\text{O}$ per 100 Gms. Solvent.	Solvent.	t°.	Gms. $\text{UO}_2\text{SO}_4 \cdot 3\text{H}_2\text{O}$ per 100 Gms. Solvent.
Water	13.2	18.9	Conc. HBr ( $d = 1.21$ )	12	16.8
Water	15.5	20.5	Conc. $\text{HNO}_3$	12	9.1
16.2% Alcohol	10	12.3	Conc. $\text{H}_2\text{SO}_4$ ( $d = 1.138$ )	13	24.3
85% Alcohol	16	2.6	1 Vol. HCl + 1 Vol. $\text{HNO}_3$	16	18
Conc. HCl	13	30	Selenic Acid ( $d = 1.4$ )	15	27

# URANYL Potassium SULFATE $\text{UO}_2\text{SO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$ .

100 gms. sat. aq. solution contain 10.41 gms.  $\text{UO}_2\text{SO}_4 \cdot \text{K}_2\text{SO}_4$  at 25° and 23—  
gms. at 70.5°. (Rimbach, 1904)

## SOLUBILITY OF $\text{UO}_2\text{SO}_4 \cdot 2\text{K}_2\text{SO}_4 \cdot 2\text{H}_2\text{O} + \text{UO}_2\text{SO}_4 \cdot \text{K}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$ IN WATER.

t°.	Gms. per 100 Gms. Solution.			Atomic Relation in Sol.			Mol. % in Solid Phase	
	$\text{UO}_2$ .	K.	$\text{SO}_4$ .	$\text{UO}_2$ .	K.	$\text{SO}_4$ .	Mono Salt.	Di Salt.
14	0.85	4.19	5.71	1 : 35.75	18.88		29	71
50	6.70	8.15	12.37	1 : 5.20	8.40		76	24
80	14.29	8.54	15.53	1 : 4.13	3.06		12	88

# URANIUM SULFATE (ous) $\text{U}(\text{SO}_4)_2$ .

## SOLUBILITY IN WATER.

(Giollitti and Bucci, 1905.)

t°.	Gms. $\text{U}(\text{SO}_4)_2$ per 100 Gms. Sat. Sol.	Solid Phase.	t°.	Gms. $\text{U}(\text{SO}_4)_2$ per 100 Gms. Sat. Sol.	Solid Phase.
18	10.17	$\text{U}(\text{SO}_4)_2 \cdot 8\text{H}_2\text{O}$	93	63.2	$\text{U}(\text{SO}_4)_2 \cdot 8\text{H}_2\text{O}$
25.6	13.32	"	24	9.8	$\text{U}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$
37	19.98	"	37	8.3	"
48.2	28.72	"	48.2	8.1 (7.8)	"
62	36.8	"	63	7.3	"

The determinations were made with difficulty on account of the considerable tendency towards formation of basic sulfate and simultaneous clouding of the solution

## APPROXIMATE SOLUBILITY OF URANIUM SULFATE, IN AQUEOUS SOLUTIONS.

(de Coninck, 1903.)

Solvent.	t°.	Gms. $\text{U}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$ per 100 Gms. Solvent.	Solvent.	t°.	Gms. $\text{U}(\text{SO}_4)_2 \cdot 4\text{H}_2\text{O}$ per 100 Gm Solvent.
Water	11	23.2	Dilute Selenic Acid (1:4)	11.4	21.7
Dilute HCl (1:4)	9	17.2	Dilute $\text{H}_2\text{SO}_4$ (1:4)	10	15.6
Dilute $\text{HNO}_3$ (1:4)	10.5	18.2	Dilute Alcohol (1:4)	11.3	12.3



$\Delta$   $\text{CO}(\text{NH}_2)_2$ .

## SOLUBILITY IN WATER AND IN ALCOHOLS.

(Campetti, 1902; Speyers, 1902.)

NOTE. — Speyer's original results are in terms of Mols.  $\text{CO}(\text{NH}_2)_2$  per 100 mols. at irregular temperatures.

In Water.			In Methyl Alcohol.		In Ethyl Alcohol.	
Wt. of 1 cc. Solution.	Gms. $\text{CO}(\text{NH}_2)_2$ per 100 Gms. $\text{H}_2\text{O}$ .		Wt. of 1 cc. Solution.	Gms. $\text{CO}(\text{NH}_2)_2$ per 100 Gms. $\text{CH}_3\text{OH}$ .	Wt. of 1 cc. Solution.	Gms. $\text{CO}(\text{NH}_2)_2$ per 100 Gms. $\text{C}_2\text{H}_5\text{OH}$ .
1.121	55.9	...	0.861	13.8	0.8213	2.5
1.134	66.0	85.0 (C)	0.863	16.0	0.814	3.5
1.146	79.0	108.2 (C)	0.869	20.0	0.809	5.0
1.156	93.0	...	0.876	24.0	0.806	6.5
1.165	106.0	...	0.890	30.0	0.804	8.5
1.173	120.0	...	0.908	37.0	0.803	10.5
1.180	132.0	...	0.928	47.0	...	13.0
1.187	145.0	...	...	...	...	17.5

0 gms. abs. methyl alcohol dissolve 21.8 gms.  $\text{CO}(\text{NH}_2)_2$  at 19.5°.

0 gms. abs. ethyl alcohol dissolve 5.06 gms.  $\text{CO}(\text{NH}_2)_2$  at 19.5°. (de Bruyn, 1903.)

## SOLUBILITY OF UREA IN ALCOHOLS.

(Timofeiew, 1894.)

Alcohol.	t°.	Gms. $\text{CO}(\text{NH}_2)_2$ per 100 Gms. Solvent.	Alcohol.	t°.	Gms. $\text{CO}(\text{NH}_2)_2$ per 100 Gms. Solvent.
thyl Alcohol	-12	11	Isopropyl Alcohol	19.4	5.76
"	0	14.2	"	20	6.17
"	19	20.9	"	81	23.46
"	40	36.4	Isobutyl Alcohol	0	1.01
"	62	66.6	"	19	1.65
"	71	107.4	"	41	3.12
yl Alcohol	-9	2.69	"	60	4.40
"	0	3.26	"	80	6.34
"	18	5	"	98	10
"	41	9.45	Isoamyl Alcohol	20	1.18
"	60	16.3	"	60	3.41
"	81	30.8	"	80	4.88
pyl Alcohol	0	1.65	"	83	5.24
"	20	2.56	"	98	6.15
"	40	5.12	Capryl Alcohol	19.4	0.56
"	60	7.72	"	98	2
"	80	12.28	Ally Alcohol	19.4	9.37
"	98	18.06			

## SOLUBILITY OF UREA IN ETHYL ACETATE CONTAINING SMALL AMOUNTS OF WATER AT 25°.

(Lewis and Burrows, 1912.)

Gms. $\text{H}_2\text{O}$ per 100 Gms. Solvent.	Gms. Urea per 100 Gms. Sat. Sol.	Gms. $\text{H}_2\text{O}$ per 100 Gms. Solvent. (Ethyl Acetate + $\text{H}_2\text{O}$ ).	Gms. Urea per 100 Gms. Sat. Sol.
0	0.080	1.677	0.308
0.652	0.148	2.006	0.328*
1.112	0.198	2.138	0.342
1.638	0.296	3.234	0.343†

A second liquid phase was suspected here.

† A second liquid phase could be distinguished.



## SOLUBILITY OF UREA IN ETHYL ETHER.

(Gortner, 1914.)

When 0.3255 gm. urea was extracted in a Soxhlet apparatus with anhydrous ether for 48 hours, the extract was found to contain 0.072 gm. urea. An approximate estimate, based on the volume of liquid and the number of siphonings per hour indicates a solubility of 0.0004 gm. urea per 100 cc. of ether.

100 gms. glycerol dissolve about 50 gms. urea at 15°.

100 gms. pyridine dissolve 0.96 gm. urea at 20-25°.

(Dehn, 1917.)

100 gms. aq. 50% pyridine dissolve 21.53 gms. urea at 20-25°.

## Diphenyl UREA.

100 gms. H<sub>2</sub>O dissolve 0.015 gm. diphenyl urea (sym or uns.?) at 20-25°.

" pyridine dissolve 6.85 gms. diphenyl urea (sym or uns.?) at 20-25°.

" aq. 50% pyridine dissolve 5.3 gms. diphenyl urea (sym or uns.?) at 20-25°.

(Dehn, 1917.)

ThioUREA NH<sub>2</sub>.CS.NH<sub>2</sub>.

100 gms. H<sub>2</sub>O dissolve 9.1 gms. thiourea at 20-25°.

" pyridine dissolve 12.5 gms. thiourea at 20-25°.

" aq. 50% pyridine dissolve 41.2 gms. thiourea at 20-25°.

(Dehn, 1917.)

Allyl ThioUREA (Thiosinamine) NH<sub>2</sub>.CS.NH.C<sub>3</sub>H<sub>5</sub>.

100 cc. H<sub>2</sub>O dissolve about 5.9 gms. NH<sub>2</sub>.CS.NH.C<sub>3</sub>H<sub>5</sub> at 15-20°.

100 cc. 90% alcohol dissolve about 50 gms. NH<sub>2</sub>.CS.NH.C<sub>3</sub>H<sub>5</sub> at 15-20°.

(Squire and Caines, 1905.)

Phenyl ThioUREA (Phenyl thiocarbamide) CS.NH<sub>2</sub>.NHC<sub>6</sub>H<sub>5</sub>.

## SOLUBILITY IN WATER.

(Rothmund, 1900; Biltz, 1903; Hollman and Antusch, 1894; Bogdan, 1902-03.)

One liter aq. solution contains 2.12 gms. CS(NH<sub>2</sub>).NHC<sub>6</sub>H<sub>5</sub> at 20° (B.), and 2.4 gms. at 25° (H. and A.). Bogdan gives 2.547 gms. at 25°.

## SOLUBILITY OF PHENYL THIOUREA AT 25° IN AQUEOUS SOLUTIONS OF.

## Potassium Nitrate.

(Bogdan, 1902-03.)

Gms. Mols. KNO <sub>3</sub> per 1000 Gms. H <sub>2</sub> O.	Gms. per 1000 Gms. H <sub>2</sub> O.	
	KNO <sub>3</sub> .	CS(NH <sub>2</sub> ). NHC <sub>6</sub> H <sub>5</sub> .
1.045	105.7	2.38
0.5123	51.84	2.48
0.2026	20.50	2.54
0.1007	10.19	2.56
0.0503	5.09	2.55
0.0333	3.36	2.55

## Sodium Nitrate.

(Bogdan, 1902-03.)

Gms. Mols. NaNO <sub>3</sub> per 1000 Gms. H <sub>2</sub> O.	Gms. per 1000 Gms. H <sub>2</sub> O.	
	NaNO <sub>3</sub> .	CS(NH <sub>2</sub> ). NHC <sub>6</sub> H <sub>5</sub> .
1.024	87.14	2.26
0.5065	43.10	2.46
0.2031	17.28	2.51
0.0986	8.39	2.53
0.0540	4.59	2.54
0.0335	2.84	2.54



## SOLUBILITY OF PHENYL THIOUREA IN AQUEOUS SALT SOLUTIONS AT 20°.

(Biltz, 1903; Rothmund, 1900.)

Solution.	Millimols and the Equivalent Gms. $\text{CS}(\text{NH}_2)\text{NHC}_6\text{H}_5$ Dissolved per Liter of Aqueous Salt Solution of Concentration:							
	0.125 Normal Millimols.	Gms.	0.25 Normal Millimols.	Gms.	0.5 Normal. Millimols.	Gms.	1 Normal. Millimols.	Gms.
	12.95	1.97	12.82	1.96	12.03	1.83	10.60	1.61
$\text{Na}_2\text{SO}_4$	14.17	2.15	14.4	2.21	14.53	2.22	14.91	2.27
	13.51	2.05	12.84	1.96	11.78	1.79	9.98	1.52
$\text{Na}_2\text{S}$	13.12	1.99	12.92	1.97	12.22	1.86	10.44	1.59
	13.98	2.13	13.98	2.13	13.90	2.12	...	...
	14.53	2.21	14.90	2.27	15.23	2.33	...	...
	13.96	2.13	13.96	2.13	13.93	2.12	13.73	2.10
$\text{Na}_2\text{S}_2\text{O}_3$	13.40	2.04	12.78	1.95	11.54	1.75	9.43	1.43
	13.40	2.04	12.95	1.97	12.14	1.85	10.74	1.62
	13.50	2.05	13.35	2.04	12.80	1.95	11.76	1.79
	13.86	2.11	13.60	2.06	13.12	1.99	...	...
	13.40	2.04	12.73	1.94	12.19	1.85	10.54	1.60
	14.12	2.15	14.48	2.21	14.31	2.18	14.60	2.23
	13.89	2.12	13.85	2.11	13.52	2.05	12.82	1.96
	14.52	2.21	14.65	2.23	13.80	2.11	12.51	1.92
	13.25	2.03	12.49	1.91	11.11	1.69	8.73	1.33
	14.22	2.16	14.44	2.19	14.39	2.18	14.22	2.17
$\text{Na}_2\text{S}_2\text{O}_4$	13.29	2.04	12.52	1.91	11.05	1.68	8.58	1.32
	13.75	2.09	13.65	2.08	13.07	1.98	12.21	1.86
	14.15	2.15	14.05	2.14	13.58	2.06	12.56	1.92
	13.28	2.02	12.83	1.95	11.90	1.81	10.02	1.52
	13.98	2.13	14.07	2.14	14.29	2.18	13.96	2.13
	13.94	2.12	13.77	2.10	13.32	2.04	12.57	1.92
	14.34	2.18	13.82	2.11	13.06	1.98	11.52	1.75
$\text{Na}_2\text{S}_2\text{O}_5$	13.19	2.00	12.35	1.87	10.85	1.63	8.30	1.27

## SOLUBILITY OF PHENYL THIOUREA IN ETHYL ALCOHOL SOLUTIONS OF SEVERAL SALTS AT 28°.

(Thorin, 1915.)

Normality of Salt in $\text{C}_2\text{H}_5\text{OH}$ .	Mols. $\text{NH}_2\text{CS.NHC}_6\text{H}_5$ per 100 Gms. Sat. Sol.	Salt.	Normality of Salt in $\text{C}_2\text{H}_5\text{OH}$ .	Mols. $\text{NH}_2\text{CS.NH.C}_6\text{H}_5$ per 100 Gms. Sat. Sol.
(pure $\text{C}_2\text{H}_5\text{OH}$ )	0.2065	NaI	0.043	0.2102
0.168	0.2274	"	0.086	0.2148
0.337	0.2360	"	0.172	0.2198
0.673	0.2440	"	0.343	0.2271
1.346	0.2494	"	0.685	0.2359
0.061	0.2101	NaBr	0.022	0.2098
0.122	0.2135	"	0.043	0.2194
0.244	0.2194	"	0.086	0.2165
0.487	0.2279	"	0.172	0.2257
0.975	0.2372			



SOLUBILITY OF PHENYL THIOUREA IN MIXTURES OF ETHYL ALCOHOL  
AND WATER AT 25°.

(Holleman and Antusch, 1894.)

Vol. per cent Alcohol.	Gms. CS(NH <sub>2</sub> ) NHC <sub>6</sub> H <sub>5</sub> per 100 Gms. Solvent.	Sp. Gr. of Solutions.	Vol. per cent Alcohol.	Gms. CS(NH <sub>2</sub> ) NHC <sub>6</sub> H <sub>5</sub> per 100 Gms. Solvent.	Sp. Gr. of Solutions.
100	3.59	...	65	3.40	0.9018
95	4.44	0.8200	60	2.80	0.9128
90	4.60	0.8389	50	1.87	0.9317
85	4.99	0.8544	40	1.13	0.9486
80	4.70	0.8679	25	0.56	0.9679
75	4.45	0.8810	15	0.38	0.9788
70	3.92	0.8915	0	0.24	0.9979

See remarks under  $\alpha$  acetonaphthalide, p. 13.SOLUBILITY OF PHENYL THIOUREA IN AQUEOUS SOLUTIONS OF PROPYL  
AND OF ETHYL ALCOHOL AT 25°.

(Bogdan, 1902-03.)

## In Aq. Propyl Alcohol.

G. Mols. C <sub>3</sub> H <sub>7</sub> OH per 1000 Gms. H <sub>2</sub> O.	Gms. per 1000 Gms. H <sub>2</sub> O	Gms. H <sub>2</sub> O
C <sub>3</sub> H <sub>7</sub> OH.	CS(NH <sub>2</sub> ) NHC <sub>6</sub> H <sub>5</sub> .	
1.035	62.10	3.587
0.5448	32.688	3.124
0.1059	6.354	2.643
0.05526	3.316	2.599
0.04854	2.912	2.586

## In Aq. Ethyl Alcohol.

G. Mols. C <sub>2</sub> H <sub>5</sub> OH per 1000 Gms. H <sub>2</sub> O.	Gms. per 1000 Gms. H <sub>2</sub> O	Gms. H <sub>2</sub> O
C <sub>2</sub> H <sub>5</sub> OH.	CS(NH <sub>2</sub> ) NHC <sub>6</sub> H <sub>5</sub> .	
1.1010	49.60	3.19
0.5355	24.12	2.93
0.1094	4.932	2.62
0.05018	2.26	2.58
0.03271	1.473	2.57

## In Propyl Alcohol at 0°.

1.000	60.06	1.21
0.100	6.01	1.047

## SOLUBILITY OF PHENYL THIOUREA IN AQUEOUS SOLUTIONS OF ACETONE, MANNITOL, CANE SUGAR, DEXTROSE, AND UREA.

(Bogdan, 1902-03.)

Aqueous Non Electro- lyte.	t°.	Gms. per 1000 Gms. H <sub>2</sub> O	Gms.
Non Elec- trolyte.		CS(NH <sub>2</sub> ) NHC <sub>6</sub> H <sub>5</sub> .	
(CH <sub>3</sub> ) <sub>2</sub> CO	25	7.478	2.667
"	"	2.513	2.579
"	"	1.908	2.573
C <sub>6</sub> H <sub>5</sub> (OH) <sub>8</sub>	"	182.11	3.04
"	"	91.05	2.78
C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	25	338.6	3.457
"	"	170.4	3.015
"	"	34.36	2.634
"	"	18.28	2.596
"	"	10.09	2.572
"	0	342.18	1.420
"	"	34.22	1.044

Aqueous Non Electro- lyte.	t°.	Gms. per 1000 Gms. H <sub>2</sub> O.	Gms.
Non Elec- trolyte.		CS(NH <sub>2</sub> ) NHC <sub>6</sub> H <sub>5</sub> .	
C <sub>6</sub> H <sub>12</sub> O <sub>8</sub>	25	180.40	3.04
"	"	90.46	2.8
"	"	29.29	2.6
"	"	18.01	2.6
"	"	9.554	2.6
CO(NH <sub>2</sub> ) <sub>2</sub>	"	63.08	3.3
"	"	29.93	2.8
"	"	6.132	2.6
"	"	4.942	2.6
"	"	2.009	2.5
"	0	60.11	1.3
"	"	6.01	1.0



**UREIDE OF GLUCOSE**  $\text{CH}_2\text{OH}(\text{CHOH})_4\text{CH} : \text{N.CO.NH}_2$ .

100 gms. absolute ethyl alcohol dissolve 0.04 gm. ureide of glucose at 25°.

"	85.6%	"	"	0.73	"	"	"
"	methyl alcohol	"	"	0.22	"	"	"

(Schoorl, 1903.)

**URETHAN** (Ethyl Carbamate)  $\text{NH}_2.\text{CO}_2.\text{C}_2\text{H}_5$ . (See also p. 296.)

## SOLUBILITY OF URETHAN IN SEVERAL SOLVENTS.

(Speyers, 1902.)

Interpolated and calculated from the original results which are given in terms molecules urethan per 100 mols. solvent.

Solubility in Water.				Solubility in Methyl Alcohol.			
t°.	Wt. of 1 cc. Solu- tion.	Mols. $\text{CO}(\text{NH}_2)$ $\text{OC}_2\text{H}_5$ per 100 Mols. $\text{H}_2\text{O}$ .	Gms. $\text{CO}(\text{NH}_2)$ $\text{OC}_2\text{H}_5$ per 100 Gms. $\text{H}_2\text{O}$ .	Wt. of 1 cc. Solu- tion.	Mols. $\text{CO}(\text{NH}_2)$ $\text{OC}_2\text{H}_5$ per 100 Mols. $\text{CH}_3\text{OH}$ .	Gms. $\text{CO}(\text{NH}_2)$ $\text{OC}_2\text{H}_5$ per 100 Gms. $\text{CH}_3\text{OH}$ .	
0	1.023	3.61	17.8	0.956	31.18	86.76	
10	1.033	6.0	29.7	0.977	41.0	114.1	
15	1.042	15.0	74.2	0.989	47.5	132.1	
20	1.060	31.0	153.3	1.000	54.5	151.7	
25	1.073	50.0	247.3	1.013	62.5	173.9	
30	1.078	65.0	321.4	1.024	72.0	200.3	
40	1.065	77.0	380.7	1.045	89.0	247.7	

Solubility in Ethyl Alcohol.				Solubility in Propyl Alcohol.			
t°.	Wt. of 1 cc. Solu- tion.	Mols. $\text{CO}(\text{NH}_2)$ $\text{OC}_2\text{H}_5$ per 100 Mols. $\text{C}_2\text{H}_5\text{OH}$ .	Gms. $\text{CO}(\text{NH}_2)$ $\text{OC}_2\text{H}_5$ per 100 Gms. $\text{C}_2\text{H}_5\text{OH}$ .	Wt. of 1 cc. Solu- tion.	Mols. $\text{CO}(\text{NH}_2)$ $\text{OC}_2\text{H}_5$ per 100 Mols. $\text{C}_3\text{H}_7\text{OH}$ .	Gms. $\text{CO}(\text{NH}_2)$ $\text{OC}_2\text{H}_5$ per 100 Gms. $\text{C}_3\text{H}_7\text{OH}$ .	
0	0.8914	23.91	46.26	0.880	19.48	28.9	
10	0.930	36.0	69.6	0.906	31.0	46.0	
15	0.950	43.0	89.2	0.923	40.0	59.3	
20	0.968	50.0	96.7	0.942	51.0	75.7	
25	0.985	59.0	114.1	0.963	60.0	89.0	
30	1.001	70.0	135.4	0.983	68.0	100.9	
40	1.035	88.0	170.2	1.025	85.0	126.1	

Solubility in Chloroform.				Solubility in Toluene.			
t°	Wt. of 1 cc. Solu- tion.	Mols. $\text{CO}(\text{NH}_2)$ $\text{OC}_2\text{H}_5$ per 100 Mols. $\text{CHCl}_3$ .	Gms. $\text{CO}(\text{NH}_2)$ $\text{OC}_2\text{H}_5$ per 100 Gms. $\text{CHCl}_3$ .	Wt. of 1 cc. Solu- tion.	Mols. $\text{CO}(\text{NH}_2)$ $\text{OC}_2\text{H}_5$ per 100 Mols. $\text{C}_6\text{H}_5\text{CH}_3$ .	Gms. $\text{CO}(\text{NH}_2)$ $\text{OC}_2\text{H}_5$ per 100 Gms. $\text{C}_6\text{H}_5\text{CH}_3$ .	
0	1.404	27.56	20.6	0.887	1.77	1.71	
10	1.340	41	30.6	0.874	5.0	4.84	
15	1.310	46	34.4	0.875	10.0	9.68	
20	1.280	53	39.6	0.883	16.0	15.48	
25	1.240	60	44.8	0.902	25.0	24.18	
30	1.203	67	50.0	0.927	44.0	42.58	
40	1.125	80	59.7	0.995	85.0	82.24	

100 gms. sat. solution in liquid  $\text{CO}_2$  contain 4 gms. urethan at the critical temperature, 23.5°; at 30.5° the mixture separates with two layers. (Böchner, 1905-06.)

100 gms. pyridine dissolve 21.32 gms. urethan at 20-25°.

(Dehn, 1917.)

100 gms. aq. 50% pyridine dissolve 101.1 gms. urethan at 20-25°.



# URETHAN

742

## SOLUBILITY OF URETHAN DERIVATIVES IN WATER.

(Odaira, 1915.)

Name.	Formula.	t°.	Gms. Cmpd. per 100 Gms. H <sub>2</sub> O.
Detonal (Diethyl Aceturethan)	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> CH.CO.NH.CO.OC <sub>2</sub> H <sub>5</sub>	...	0.526
Epronal (Ethylpropyl Aceturethan)	(C <sub>2</sub> H <sub>5</sub> )(C <sub>3</sub> H <sub>7</sub> )CH.CO.NH.CO.OC <sub>2</sub> H <sub>5</sub>	cold	0.143
Dipronal (Dipropyl Aceturethan)	(C <sub>3</sub> H <sub>7</sub> ) <sub>2</sub> CH.CO.NH.CO.OC <sub>2</sub> H <sub>5</sub>	20	0.040
Probinal (Propylbutyl Aceturethan)	(C <sub>3</sub> H <sub>7</sub> )(C <sub>4</sub> H <sub>9</sub> )CH.CO.NH.CO.OC <sub>2</sub> H <sub>5</sub>	20	0.032
Dibnal (Dibutyl Aceturethan)	(C <sub>4</sub> H <sub>9</sub> ) <sub>2</sub> CH.CO.NH.CO.OC <sub>2</sub> H <sub>5</sub>	20	0.008
Oenanthyl Urethan	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>7</sub> .CO.NH.CO.OC <sub>2</sub> H <sub>5</sub>	...	0.021
* Isoamyl Urethan	(C <sub>5</sub> H <sub>11</sub> ) <sub>2</sub> CH.NH.CO.OC <sub>2</sub> H <sub>5</sub>	20	0.410
α Bromethyl Propyl Aceturea	(C <sub>3</sub> H <sub>7</sub> )(C <sub>2</sub> H <sub>5</sub> )CBr.CO.NH.CO.NH <sub>2</sub>	20	0.041

## DISTRIBUTION OF URETHAN DERIVATIVES BETWEEN WATER AND OLIVE OIL.

Name.	Formula.	t°.	Gms. Cmpd. per 100 cc.		Dist. Ratio
			H <sub>2</sub> O Layer.	Olive Oil Layer.	Conc <sup>n</sup> Conc <sup>o</sup>
Ethyl Urethan	NH <sub>2</sub> COOC <sub>2</sub> H <sub>5</sub>	ord.	4.52	0.615	0.136(1)
Methyl Urethan	NH <sub>2</sub> COOCH <sub>3</sub>	ord.	7.50	0.275	0.037(1)
Aceturethan	CH <sub>3</sub> CONH.COOC <sub>2</sub> H <sub>5</sub>	17-20	2.94	0.389	0.132(2)
Epronal	(C <sub>2</sub> H <sub>5</sub> )(C <sub>3</sub> H <sub>7</sub> )CH.CO.NH.CO.OC <sub>2</sub> H <sub>5</sub>	"	0.076	0.257	3.3(2)
Detonal	(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub> CH.CO.NH.CO.OC <sub>2</sub> H <sub>5</sub>	"	{ 0.122	0.213	1.8(2)
			{ 0.326	0.549	1.7(2)
Veronal (diethylbarbituric acid)	CO(NHCO) <sub>2</sub> C.(C <sub>2</sub> H <sub>5</sub> ) <sub>2</sub>	"	{ 0.180	0.020	0.11(2)
			{ 0.268	0.032	0.12(2)

(1) Baum, 1899; H. von Meyer, 1909.

(2) Odaira, 1915.

# URIC ACID C<sub>5</sub>H<sub>4</sub>N<sub>4</sub>O<sub>3</sub>.

## SOLUBILITY IN WATER.

(Blarez and Deniges, 1887; at 15° Magnier, 1875.)

t°.	Gms. C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O <sub>3</sub> per 100 Gms. H <sub>2</sub> O.	t°.	Gms. C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O <sub>3</sub> per 100 Gms. H <sub>2</sub> O.	t°.	Gms. C <sub>5</sub> H <sub>4</sub> N <sub>4</sub> O <sub>3</sub> per 100 Gms. H <sub>2</sub> O.
0	0.002	30	0.0088	70	0.0305
10	0.0037	40	0.0122	80	0.0390
15	0.0053	50	0.0170	90	0.0498
20	0.006	60	0.0230	100	0.0625

One liter of very carefully purified CO<sub>2</sub> free water dissolves 0.0253 gm. uric acid at 18°. Constant agitation and temperature were employed. With finely divided uric acid, saturation was reached after one hour. The amount dissolved was determined by the difference in weight between the amount of sample taken and that remaining undissolved.

(His, Jr. and Paul, 1900.)

One liter of pure CO<sub>2</sub> free water dissolves 0.0649 gm. uric acid at 37°. The amount dissolved was determined by difference and only 20-25 minutes agitation allowed for saturation. It is stated that on long contact with water, the uric acid breaks down and the solubility and conductivity increase directly with time.

(Gudzeit, 1909.)

One liter of water dissolves 0.0645 gm. uric acid at 37°. (Bechhold and Ziegler, 1910.)

One liter of serum dissolves 0.9 gm. uric acid at 37°.

"



## SOLUBILITY OF URIC ACID IN AQUEOUS SOLUTIONS OF ACID AT 18°.

(His, Jr. and Paul, 1900.)

Acid.	Concentration of Aq. Acid.		Gms. Uric Acid per 1000 cc. Sat. Sol.
	Normality.	Per cent.	
Hydrochloric	1	3.65	0.0236
"	3.75	13.69	0.0263
"	6.24	22.77	0.0375
Sulfuric	1	4.9	0.0227
	3.2	15.67	0.0205
	6.4	31.34	0.0183

Additional data for the solubility of uric acid in aqueous sulfuric acid are given by Tafel (1901). A saturated solution of crystallized uric acid in 80 wt. per cent aqueous  $H_2SO_4$  was prepared by warming to about 120° and allowing to stand. Portions of the clear solution were diluted with increasing amounts of water and the mixtures allowed to stand many days in closed flasks which were frequently shaken. The precipitated uric acid was then filtered off and weighed and the amount remaining in solution calculated by difference. The following results were obtained.

Wt. % of aq. $H_2SO_4$	72.5	70.5	68	66.5	62.5	59.5
Gms. uric acid per 100 gms. aq. $H_2SO_4$	6.45	3.85	1.60	0.64	0.35	0.312

An approximate determination of the solubility of uric acid in alcohol by extraction in a Soxhlet apparatus, gave 0.00008 gms. per 100 cc. A similar determination with ether as solvent, gave negative results. (Gortner, 1914.)

100 gms. 95% formic acid dissolve 0.04 gm. uric acid at 20°. (Aschan, 1913.)  
 " pyridine dissolve 0.21 gm. uric acid at 20-25°. (Dehn, 1917.)  
 " aq. 50% pyridine dissolve 0.75 gms. uric acid at 20-25°. "

**VALERIC ACID**  $n$   $CH_3(CH_2)_nCOOH$  ( $n$  Propyl Acetic Acid).

When valeric acid is shaken with water at 16°, two layers are formed.

100 gms. of the aqueous layer contain 3.4 gms.  $CH_3(CH_2)_4COOH$ .

100 gms. of the acid layer contain 90.4 gms.  $CH_3(CH_2)_4COOH$ .

(Lieben and Rossi, 1871.)

**DISTRIBUTION OF VALERIC ACID BETWEEN BENZENE AND 95.8% SULFURIC ACID.**

(Gurwitsch, 1914.)

The mixtures were made at 0° and brought to equilibrium by shaking for 5 minutes at 18°, and allowing to stand over night.

Gms. Valeric Acid per 100 Gms.		Gms. Valeric Acid per 100 Gms.	
Benzene Layer.	$H_2SO_4$ Layer.	Benzene Layer.	$H_2SO_4$ Layer.
7.60	46.4	1	36.7
4.78	44.8	0.58	35.2
3.64	43.5	0.29	32.7
2.61	41.4	0.20	30.7
1.62	39.5	0.04	26.1
1.48	38.1	0.007	23.8

The coefficient of distribution of isovaleric acid between benzene and water at room temperature is, conc. in  $C_6H_6$  ÷ conc. in  $H_2O$  = 2.744. (King and Narracott, 1909.)



## VALERAMIDES

744

DISTRIBUTION OF VALERAMIDES BETWEEN WATER AND OLIVE OIL AT 15°.  
(Harrass, 1903.)

Amide.	Formula.	Gms. Cmpd. per per 100 cc.		Ratio Conc. a Conc. b
		Water Layer.	Olive Oil Layer.	
Valeramide	$\text{CH}_3(\text{CH}_2)_3\text{CONH}_2$	0.769	0.241	0.313
Valerethylamide	$\text{CH}_3(\text{CH}_2)_3\text{CONH}(\text{C}_2\text{H}_5)$	1.029	0.261	0.254
Valerdiethylamide	$\text{CH}_3(\text{CH}_2)_3\text{CON}(\text{C}_2\text{H}_5)_2$	0.231	1.339	5.797
Valerdimethylamide	$\text{CH}_3(\text{CH}_2)_3\text{CON}(\text{CH}_3)_2$	0.011	0.379	0.416
Lactdiethylamide	$\text{CH}_3\text{CHOHCON}(\text{C}_2\text{H}_5)_2$	1.256	0.194	0.154

## VANILLIN $\text{C}_8\text{H}_8\text{CHO.OCH}_3\text{OH}$ , 1.3.4.

100 gms.  $\text{H}_2\text{O}$  dissolve 1 gm. vanillin at 20-25°.

(Deha, 1917)

100 gms. pyridine dissolve 316 gms. vanillin at 20-25°.

DISTRIBUTION OF VANILLIN BETWEEN WATER AND ETHER AT 25°.  
(Marden, 1914.)

Gms. Vanillin per 100 cc.		Dist. Coef.
$\text{H}_2\text{O}$ Layer.	Ether Layer.	
0.0164	0.1294	0.108
0.0242	0.1854	0.110
0.0403	0.3310	0.104

Fusion-point data for mixtures of vanillin and orthovanillin are given by Noelting (1910). Qualitative solubilities of orthovanillin in a number of solvents are also reported. Data for the sintering, melting and clear liquid points for mixtures of vanillin and an extensive series of compounds are given by Lehmann (1914).

## VERATRINE $\text{C}_{27}\text{H}_{48}\text{NO}_{11}$ .

SOLUBILITY IN SEVERAL SOLVENTS.

Solvent.	t°.	Gms. Veratrine per 100 Gms. Solvent.	Authority.
Water	25	0.057	(U. S. P. VIII.)
Water	20	0.114	(Zalai, 1910.)
3% $\text{H}_3\text{BO}_3$ in Aq.			
50% Glycerol	ord.	6	(Baroni & Barinnetto, 1911.)
Aniline	20	37	(Scholtz, 1911.)
Pyridine	20	175	"
Piperidine	20	83	"
Diethylamine	20	271	"
Oil of Sesame	20	1.39	(Zalai, 1910.)

## VERATROLE $\text{C}_8\text{H}_8(\text{OCH}_3)_2$ .

F.-pt. data for mixtures of veratrole and *p* xylene are given by Paterno and Ampola (1897).

## VERONAL (Diethylbarbituric Acid) $\text{CO} < (\text{NHCO})_2 > \text{C}(\text{C}_2\text{H}_5)_2$ . See also p. 742.

100 cc.  $\text{H}_2\text{O}$  dissolve 0.625 gm. veronal at 15-20°.

(Squire & Caines, 1905.)

100 cc. 90% alcohol dissolve 11.7 gms. veronal at 15-20°.

100 cc. ether dissolve 8.7 gms. veronal at 15-20°.

## VESUVIN.

100 gms. water	dissolve	8.5 gms. vesuvin at 20-25°.	(Deha, 1917.)
pyridine	"	11.1	"
aq. 50% pyridine	"	31.4	"



WATER.  $H_2O$ .

## SOLUBILITY OF WATER IN BENZENE, PETROLEUM AND PARAFFINE OIL.

(Groschuff, 1911.)

The synthetic, sealed tube method was used and the experiments were made with very great care. The mixtures were first superheated sufficiently to bring the water into solution and then cooled until a fine mist was formed. The temperature of appearance and disappearance of this fine mist was determined separately. The benzene was of  $d_{20} = 0.8799$ . The petroleum was American standard white, of  $d = 0.792$ . It was freed from  $H_2O$  by distilling 3 times from fused Na and boiled at  $190-250^\circ$  at atmospheric pressure. The paraffine oil was first heated to  $120-130^\circ$  and then distilled twice under vacuum over melted and once without Na. Its  $d_{15} = 0.883$  and b.-pt. was  $200^\circ-300^\circ$  at 10 mm. pressure.

Results for:

$H_2O + \text{Benzene.}$		$H_2O + \text{Petroleum.}$		$H_2O + \text{Paraffine Oil.}$	
$t^\circ$ .	Gms. $H_2O$ per 100 Gms. Sol.	$t^\circ$ .	Gms. $H_2O$ per 100 Gms. Sol.	$t^\circ$ .	Gms. $H_2O$ per 100 Gms. Sol.
3	0.030	— 2	0.0012	+16	0.003
23	0.061	+18	0.005	61	0.013
40	0.114	23	0.007	66	0.022
55	0.184	30	0.008	79	0.030
66	0.255	36	0.012	85	0.035
77	0.337	53	0.026	94	0.055

Observations on the solubility of water in essential oils are given by Umney and Walker (1912).

## NON Xe.

## SOLUBILITY IN WATER.

(von Antropoff, 1909-10.)

The results are in terms of the coef. of absorption  $\beta$ , as defined by Bunsen (see 27) and modified by Kuenen in respect to the substitution of mass for volume of water.

$t^\circ$ .	$0^\circ$ .	$10^\circ$ .	$20^\circ$ .	$30^\circ$ .	$40^\circ$ .	$50^\circ$ .
bs. Coef. $\beta$	0.2180	0.1500	0.1109	0.0900	0.0812	0.0878

## DIOXYLENES.

100 gms. 95% formic acid dissolve 0.71 gm. trinitro-*m*-xylene (m. pt.  $173^\circ$ ) at  $5^\circ$ .  
(Aschan, 1913.)  
b.-pt. data for mixtures of 2,3, dinitro-*p*-xylene and 2,6, dinitro-*p*-xylene are given by Blanksma (1913).

XYLENOL 1,3,4,  $C_6H_3(CH_3)_3.OH$ .

## SOLUBILITY OF AQUEOUS ALKALINE SOLUTIONS OF XYLENOL WITH SEVERAL ORGANIC COMPOUNDS, INSOLUBLE IN WATER.

(Sheuble, 1907.)

To 5 cc. portions of aq. KOH solution (250 gms. per liter) were added the given amounts of the aq. insoluble compound from a buret and the xyleneol, dropwise, until solution occurred. Temperature not stated.

## Composition of Homogeneous Solution.

cc. Aq. KOH.	cc. Aq. Insol. Cmpd.	Gms. Xyleneol.
5	2 (= 1.64 gms.) Octyl Alcohol (1)	1
5	5 (= 4.10 " ) " "	1.7
5	2 (= 1.74 " ) Toluene	4.1
5	3 (= 2.61 " ) " "	5

1) The normal secondary octyl alcohol, i.e., the so-called capryl alcohol,  $CH_3(CH_2)_6.CH(OH)CH_3$ .



**YTTERBIUM**

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**YTTERBIUM CobaltiCYANIDE**  $\text{Yb}_2(\text{CoC}_6\text{N}_6)_2 \cdot 9\text{H}_2\text{O}$ .

1000 gms. aqueous 10% HCl ( $d_{16} = 1.05$ ) dissolve 0.38 gm. of the salt at 25°.  
(James and Willard, 1916.)

**YTTERBIUM OXALATE**  $\text{Yb}_2(\text{C}_2\text{O}_4)_3 \cdot 10\text{H}_2\text{O}$ .

## SOLUBILITY IN WATER AND IN SEVERAL AQUEOUS SOLUTIONS.

Aqueous Solution of:	Per cent Conc. of Aq. Sol.	t°.	Gms. $\text{Yb}_2(\text{C}_2\text{O}_4)_3$ per 100 cc. Solvent.	Authority.
Water	...	25	0.000334	(Rimbach and Schubert, 1909.)
$(\text{NH}_4)_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$	3.26	ord.	0.095	(Cleve, 1902.)
Methylamine Oxalate	20	"	5.24*	(Grant and James, 1917.)
Ethylamine Oxalate	20	"	5.86*	"
Triethylamine Oxalate	20	"	2.05*	"
Sulfuric Acid (1 N)	4.9	"	0.372	(Cleve, 1902.)

\* The authors do not state whether their figures are for anhydrous or hydrated salt.

**YTTERBIUM Dimethyl PHOSPHATE**  $\text{Yb}_2[(\text{CH}_3)_2\text{PO}_4]_6$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 1.2 gms.  $\text{Yb}_2[(\text{CH}_3)_2\text{PO}_4]_6$  at 25° and 0.25 gm. at 95°.  
(Morgan and James, 1914.)

**YTTERBIUM SULFATE**  $\text{Yb}_2(\text{SO}_4)_3 \cdot 8\text{H}_2\text{O}$ .SOLUBILITY IN WATER.  
(Cleve, 1902.)

t°.	Gms. $\text{Yb}_2(\text{SO}_4)_3$ per 100 gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{Yb}_2(\text{SO}_4)_3$ per 100 Gms. $\text{H}_2\text{O}$ .	t°.	Gms. $\text{Yb}_2(\text{SO}_4)_3$ per 100 Gms. $\text{H}_2\text{O}$ .
0	44.2	55	11.5	80	6.92
15.5	34.6	60	10.4	90	5.83
35	19.1	70	7.22	100	4.67

**YTTERBIUM Bromonitrobenzene SULFONATE**  $\text{Yb}(\text{C}_6\text{H}_4\text{Br} \cdot \text{NO}_2 \cdot \text{SO}_3, 1,4,3) \cdot 12\text{H}_2\text{O}$ .

100 gms. sat. solution in water contain 7.294 gms. of the anhydrous salt at 25°.  
(Katz and James, 1913.)

**YTTRIUM CHLORIDE**  $\text{YCl}_3$ .

100 gms. alcohol dissolve 61.1 gms.  $\text{YCl}_3$  at 15°.  
" " " 60.5 gms.  $\text{YCl}_3$  at 20°.  
" pyridine dissolve 6.5 gms.  $\text{YCl}_3$  at 15°.  
(Matignon, 1906.)  
(Matignon, 1909.)  
(Matignon, 1906.)

**YTTRIUM CobaltiCYANIDE**  $\text{Y}_2(\text{CoC}_6\text{N}_6)_2 \cdot 9\text{H}_2\text{O}$ .

1000 gms. aq. 10% HCl ( $d_{16} = 1.05$ ) dissolve 2.78 gms. of the salt at 25°.  
(James and Willard, 1916.)

**YTTRIUM GLYCOLATE**  $\text{Y}(\text{C}_2\text{H}_3\text{O}_4)_3 \cdot 2\text{H}_2\text{O}$ .

One liter of water dissolves 2.447 gms. of the salt at 20°.  
(Jantsch and Grünkraut, 1912-1913.)

**YTTRIUM IODATE**  $\text{Y}(\text{IO}_3)_3 \cdot 3\text{H}_2\text{O}$ .

100 gms.  $\text{H}_2\text{O}$  dissolve 0.53 gm. yttrium iodate.  
(Berlin.)

**YTTRIUM MALONATE**  $\text{Y}_2(\text{C}_3\text{H}_3\text{O}_4)_3 \cdot 8\text{H}_2\text{O}$ .SOLUBILITY IN AQUEOUS MALONIC ACID AND AMMONIUM MALONATE SOLUTIONS.  
(Holmberg, 1907.)

Solvent.	t°.	Gms. $\text{Y}_2(\text{C}_3\text{H}_3\text{O}_4)_3$ per 100 Gms. Solvent.
1 Gm. Am. Malonate per 10 cc. Solution	20	0.3
2 Gms. Malonic Acid per 10 cc. Solution	20	2.3



**YTTRIUM Basic NITRATE**  $3Y_2O_3 \cdot 4N_2O_5 \cdot 2H_2O$ .

EQUILIBRIUM IN THE SYSTEM YTTRIUM NITRATE, YTTRIUM HYDROXIDE AND WATER AT 25°. (James and Pratt, 1910.)

The determinations were made with very great care. The mixtures were rotated 4½ months.

$d_m$ of Sat. Sol.	Gms. per 100 Gms. $H_2O$ .		Solid Phase.	$d_m$ of Sat. Sol.	Gms. per 100 Gms. $H_2O$ .		Solid Phase.
	$Y(NO_3)_3$	$Y_2O_3$ as $Y(OH)_3$			$Y(NO_3)_3$	$Y_2O_3$ as $Y(OH)_3$	
1.0260	3.13	0.014	$Y(OH)_3$	1.4867	73.03	0.078	$3Y_2O_3 \cdot 4N_2O_5 \cdot 2H_2O$
1.1106	13.87	0.034	"	1.5587	89.06	0.074	"
1.1907	24.94	0.063	"	1.6259	103.80	0.075	"
1.2517	33.02	0.160	" + $3Y_2O_3 \cdot 4N_2O_5 \cdot 2H_2O$	1.6931	122.40	0.080	"
1.3268	44.35	0.114	$3Y_2O_3 \cdot 4N_2O_5 \cdot 2H_2O$	1.7440	137.10	0.083	" + $\gamma(NO_3)_3$
1.4104	58.61	0.095	"	1.7446	141.6	0	$Y(NO_3)_3$

**YTTRIUM OXALATE**  $Y_2(C_2O_4)_3 \cdot 9H_2O$ .One liter  $H_2O$  dissolves 0.001 gm.  $Y_2(C_2O_4)_3$  at 25°, determined by the electrolytic method. (Rimbach and Schubert, 1909.)100 gms. aqueous ammonium oxalate solution (3.26%  $(NH_4)_2C_2O_4 \cdot H_2O$ ) dissolve 0.01714 gm.  $Y_2(C_2O_4)_3 \cdot 9H_2O$  at room temp. (Cleve, 1902.)100 gms. aq. 2.16  $\%$   $H_2SO_4$  dissolve 0.6884 gm.  $Y_2(C_2O_4)_3$  at 25°. (Wirth, 1912.)100 gms. aq. 4.32  $\%$   $H_2SO_4$  dissolve 1.4 gms.  $Y_2(C_2O_4)_3$  at 25°. "

100 cc. aq. 20% methylamine oxalate dissolve 0.877 gm. yttrium oxalate at ord. temp.

100 cc. aq. 20% ethylamine oxalate dissolve 1.653 gms. yttrium oxalate at ord. temp.

100 cc. aq. 20% triethylamine oxalate dissolve 1.006 gms. yttrium oxalate at ord. temp. (Grant and James, 1917.)

**YTTRIUM Potassium OXALATE**  $Y_2(C_2O_4)_3 \cdot 4K_2C_2O_4 \cdot 12H_2O$ .

SOLUBILITY IN WATER AT 25°. (Pratt and James, 1911.)

The determinations were made with great care. The mixtures were constantly rotated for 8 weeks.

$d_m$ of Sat. Sol.	Gms. per 100 Gms. $H_2O$ .		Solid Phase.	$d_m$ of Sat. Sol.	Gms. per 100 Gms. $H_2O$ .		Solid Phase.
	$Y_2(C_2O_4)_3$	$K_2C_2O_4$			$Y_2(C_2O_4)_3$	$K_2C_2O_4$	
1.008	Trace	1.31	Solid Solution	1.174	1.50	27.44	$Y_2(C_2O_4)_3 \cdot 4K_2C_2O_4 \cdot 12H_2O$
1.035	0.02	5.30	"	1.199	1.49	32.83	"
1.059	0.06	8.88	"	1.222	1.48	37.68	"
1.096	0.27	14.50	"	1.231	1.42	39.12	$K_2C_2O_4$
1.132	0.72	20.27	"	1.228	1.09	38.77	"
1.166	1.37	26.02	$Y_2(C_2O_4)_3 \cdot 4K_2C_2O_4 \cdot 12H_2O$	1.218	0	37.87	"

**YTTRIUM DimethylPHOSPHATE**  $Y_2[(CH_3)_2PO_3]_4$ .100 gms.  $H_2O$  dissolve 2.8 gms.  $Y_2[(CH_3)_2PO_3]_4$  at 25° and 0.55 gm. at 95°. (Morgan and James, 1914.)**YTTRIUM SULFATE**  $Y_2(SO_4)_3$ .

SOLUBILITY OF YTTRIUM SULFATE IN AQUEOUS SOLUTIONS OF SODIUM SULFATE AT 25°. (James and Holden, 1913.)

Equilibrium was reached very slowly and it was necessary to rotate the mixtures for 14 months before final equilibrium was reached.

Gms. per 100 Gms. $H_2O$ .		Solid Phase.	Gms. per 100 Gms. $H_2O$ .		Solid Phase.
$Y_2(SO_4)_3$	$Na_2SO_4$		$Y_2(SO_4)_3$	$Na_2SO_4$	
5.61	1.29	$Y_2(SO_4)_3$	1.90	14.89	$Y_2(SO_4)_3 \cdot Na_2SO_4 \cdot 2H_2O$
6.38	3.85	"	1.79	16.51	"
7.40	6.21	"	1.86	18.44	"
8.43	8.53	" + $Y_2(SO_4)_3 \cdot Na_2SO_4 \cdot 2H_2O$	2.99	19.96	"
5.86	7.57	$Y_2(SO_4)_3 \cdot Na_2SO_4 \cdot 2H_2O$	3.04	21.05	"
4.75	7.72	"	2.27	27.14	"
3.42	10.14	"	1.52	28.22	"
2.36	11.36	"	1.61	28.13	"
2.02	13.42	"	5.38	0	$Na_2SO_4 \cdot 10H_2O$



## YTTRIUM SULFONATES

748

### SOLUBILITY OF YTTRIUM SULFONATES IN WATER.

Sulfonate.	Formula.	Gms. Anhy. Sulfonate per 100 Gms. H <sub>2</sub> O.	Authority.
Yttrium Benzene Sulfonate	$Y(C_6H_5SO_3)_3 \cdot 9H_2O$	15 60.4	(Holmberg, 1907.)
" " " Nitro- benzene Sulfonate	$Y(C_6H_4NO_2SO_3)_3 \cdot 7H_2O$	15 48.3	
Yttrium Bromonitrobenzene Sulfonate	$Y(C_6H_4BrNO_2SO_3)_{1.4.2} \cdot 10H_2O$	25 3.88	(Katz & James, '13.)

## YTTRIUM TARTRATE $Y_2(C_4H_4O_6)_3 \cdot 5H_2O$ .

### SOLUBILITY IN AQUEOUS TARTARIC ACID AND AMMONIUM TARTRATE SOLUTIONS AT 20°. (Holmberg, 1907.)

Aq. Solvent.	Gms. $Y_2(C_4H_4O_6)_3$ per 100 Gms. Sat. Sol.	Aq. Solvent.	Gms. $Y_2(C_4H_4O_6)_3$ per 100 Gms. Sat. Sol.
1 gm. Am. Tartrate per 10 cc. solution	0.6	2 gms. Tartaric Acid per 10 cc. solution	0.02
2 gms. Am. Tartrate per 10 cc. solution	1.1	4 gms. Tartaric Acid per 10 cc. solution	0.02

## ZEIN (Protein from Corn).

### SOLUBILITY IN AQUEOUS ALCOHOL SOLUTIONS AT 25°. (Galeotti and Giampalmo, 1908.)

Dry powdered zein was added to the alcohol + water mixtures and the solutions kept at 25° and shaken frequently during 24 hrs. The removed undissolved residue was dried to constant weight and weighed.

Vol. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	Gms. Zein per 100 Gms. Sat. Sol.	Vol. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	Gms. Zein per 100 Gms. Sat. Sol.
10	0.05	60	18.57
20	0.11	70	19.87
30	0.21	80	7.81
40	0.51	90	4.51
50	1.43	100	0.02

Similar results are given for the solubility of zein in mixtures of C<sub>2</sub>H<sub>5</sub>OH + H<sub>2</sub>O + CHCl<sub>3</sub> at 20° and C<sub>2</sub>H<sub>5</sub>OH + H<sub>2</sub>O + acetone at 25°.

## ZINC ACETATE $Zn(C_2H_3O_2)_2 \cdot 2H_2O$ .

### SOLUBILITY IN AQUEOUS ETHYL ALCOHOL AT 25°. (Seidell, 1910.)

Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	$d_{25}$ of Sat. Sol.	Gms. Zn- (C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 2H <sub>2</sub> O per 100 Gms. Sat. Sol.	Wt. % C <sub>2</sub> H <sub>5</sub> OH in Solvent.	$d_{25}$ of Sat. Sol.	Gms. Zn- (C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> · 2H <sub>2</sub> O per 100 Gms. Sat. Sol.
0	1.168	30.80	60	0.920	10.60
10	1.127	27.20	70	0.880	7.80
20	1.090	23.70	80	0.850	5.50
30	1.055	20.40	90	0.830	4.20
40	1.015	17	95	0.825	4
50	0.970	13.80	100	0.796	1.18*

\* = gms. anhydrous salt. The solid phase was Zn(C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub> · 2H<sub>2</sub>O in all cases except this solution.

100 gms. H<sub>2</sub>O dissolve 41.6 gms. Zn(C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub> · 2H<sub>2</sub>O at 15°,  $d$  of sat. sol. = 1.165. (Greenish and Smith, 1902.)

100 cc. anhydrous hydrazine dissolve 4 gms. zinc acetate with separation of a white suspension at ordinary temperature. (Welsh and Broderson, 1911.)

## ZINC ARSENATE $Zn_3(AsO_4)_2 \cdot 8H_2O$ .

100 gms. 95% formic acid dissolve 0.26 gm. Zn<sub>3</sub>(AsO<sub>4</sub>)<sub>2</sub> at 21°. (Aschan, 1913.)

## ZINC ARSENITE $Zn_3(AsO_3)_2$ .

100 gms. 95% formic acid dissolve 0.36 gm. Zn<sub>3</sub>(AsO<sub>3</sub>)<sub>2</sub> at 21°. (Aschan, 1913.)



**BENZOATE**  $\text{Zn}(\text{C}_7\text{H}_5\text{O}_2)_2$ .SOLUBILITY IN WATER.  
(Pajetta, 1906.)

t°.	15.9°.	17°.	27.8°.	31.3°.	37.5°.	49.8°.	59°.
$\text{Zn}(\text{C}_7\text{H}_5\text{O}_2)_2$ per gms. aq. solution	2.55	2.49	2.41	2.05	1.87	1.62	1.45

**BROMIDE**  $\text{ZnBr}_2 \cdot 2\text{H}_2\text{O}$ .SOLUBILITY IN WATER.  
(Diets, 1900; see also Etard, 1894.)

Gms. $\text{ZnBr}_2$ per 100 Gms. Solution.	Mols. $\text{ZnBr}_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{ZnBr}_2$ per 100 Gms. Solution.	Mols. $\text{ZnBr}_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
77.13	27.0	$\text{ZnBr}_2 \cdot 3\text{H}_2\text{O}$	25	82.46	37.6	$\text{ZnBr}_2 \cdot 3\text{H}_2\text{O}$
78.45	29.1	"	30	84.08	42.3	"
80.64	33.3	"	37	86.20	50.0	"
79.06	30.2	$\text{ZnBr}_2 \cdot 3\text{H}_2\text{O}$	35	85.45	46.9	$\text{ZnBr}_2$
79.55	31.1	"	40	85.53	47.4	"
80.76	33.5	"	60	86.08	49.5	"
81.46	35.1	"	80	86.57	51.5	"
			100	87.05	53.8	"

**BICARBONATE**  $\text{Zn}(\text{HCO}_3)_2$ .SOLUBILITY OF ZINC BICARBONATE IN WATER CONTAINING CARBON DIOXIDE.  
(Smith, 1918.)

Description of the experimental method see iron bicarbonate, p. 336.

Pressure in atmospheres of alc. by Law.	Results at 25°.		Results at 30°.	
	Gm. Mols. Free $\text{H}_2\text{CO}_3$ per Liter.	Gm. Mols. $\text{Zn}(\text{HCO}_3)_2$ per Liter.	Gm. Mols. Free $\text{H}_2\text{CO}_3$ per Liter.	Gm. Mols. $\text{Zn}(\text{HCO}_3)_2$ per Liter.
12	0.1390	0.00194	0.1838	0.00215
33	0.1797	0.00211	0.3838	0.00277
64	0.2579	0.00242	0.4038	0.00286
61	0.3580	0.00270	0.4601	0.00308
16	0.4103	0.00278	0.6064	0.00324
29	0.4480	0.00291	0.6257	0.00337
73	0.6657	0.00317	0.7470	0.00352
65	0.6969	0.00319	0.8351	0.00376
56	0.7610	0.00343	1.0840	0.00339
61	1.3701	0.00445	1.1275	0.00429

Calculated pressures are lower than the actual pressures since Henry's Law does not hold at very high pressures.

Zinc carbonate were not hydrolytically dissociated, its solubility in pure water at 25°, would be  $4.58 \times 10^{-4}$  gms. mols. per liter." (Smith, 1918.)

**CARBONATE**  $\text{ZnCO}_3$ .

Orland and Valla (1911) report that the solubility of  $\text{ZnCO}_3$  in water at 25° is 0.206 gm. per liter.

Water of aq. 5.85% NaCl solution dissolves 0.0586 gm.  $\text{ZnCO}_3$  at 14°. Water of aq. 7.45% NaCl solution dissolves 0.0477 gm.  $\text{ZnCO}_3$  at 14°. (Cantoni and Parnamanik, 1905.)



# ZINC CHLORATE

750

## ZINC CHLORATE $\text{ZnClO}_3$ .

### SOLUBILITY IN WATER.

(Meusser, 1902; at 18°, Mylius and Funk, 1897.)

t°.	Gms. $\text{Zn}(\text{ClO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Zn}(\text{ClO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Zn}(\text{ClO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Zn}(\text{ClO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
-18	55.62	9.70	$\text{Zn}(\text{ClO}_3)_2 \cdot 6\text{H}_2\text{O}$	30	67.66	16.20	$\text{Zn}(\text{ClO}_3)_2 \cdot 4\text{H}_2\text{O}$
0	59.19	11.08	"	40	69.06	17.29	"
8	60.20	11.72	"	55	75.44	24	"
15	67.32	15.96	"	Ice curve			
18	66.52	15.39	$\text{Zn}(\text{ClO}_3)_2 \cdot 4\text{H}_2\text{O}$	-13	30.27	3.36	Ice
				-9	26.54	2.80	"

Sp. Gr. of solution saturated at 18° = 1.916.

## ZINC CHLORIDE $\text{ZnCl}_2$ .

### SOLUBILITY IN WATER.

(Mylius and Dietz, 1905; see also Dietz, 1900; Etard, 1894.)

t°.	Gms. $\text{ZnCl}_2$ per 100 Gms.		Solid Phase.	t°.	Gms. $\text{ZnCl}_2$ per 100 Gms.		Solid Phase.
	Water.	Solution.			Water.	Solution.	
-5	14	12.3	Ice	9	360	78.3	$\frac{1}{2}\text{H}_2\text{O} + \text{H}_2\text{O}$
-10	25	20.0	"	6	385	79.4	$\text{ZnCl}_2 \cdot \frac{1}{2}\text{H}_2\text{O}$
-40	83	45.3	"	6	298	74.9	$\text{ZnCl}_2 \cdot \frac{1}{2}\text{H}_2\text{O}$
-62	104	51.0	Ice + $\text{ZnCl}_2 \cdot 4\text{H}_2\text{O}$	10	330	76.8	"
-50	113	53.0	$\text{ZnCl}_2 \cdot 4\text{H}_2\text{O}$	20	368	78.6	"
-40	127	55.9	"	26	423	80.9	$\frac{1}{2}\text{H}_2\text{O} + \text{ZnCl}_2 \cdot \text{H}_2\text{O}$
-30	160	61.5	$\frac{1}{2}\text{H}_2\text{O} + \frac{1}{2}\text{H}_2\text{O}$	26.3	433	81.2	$\frac{1}{2}\text{H}_2\text{O} + \text{ZnCl}_2$
-10	189	65.4	$\text{ZnCl}_2 \cdot 3\text{H}_2\text{O}$	0	342	77.4	$\text{ZnCl}_2 \cdot \text{H}_2\text{O}$
0	208	67.5	"	10	364	78.4	"
+5	230	69.7	"	20	396	79.8	"
6.5	252.4	71.6	"	28	436	81.3	$\text{ZnCl}_2 \cdot \text{H}_2\text{O} + \text{ZnCl}_2$
5	282	73.8	"	31	477	82.7	$\text{ZnCl}_2 \cdot \text{H}_2\text{O}$
0	309	75.5	$\frac{1}{2}\text{H}_2\text{O} + \frac{1}{2}\text{H}_2\text{O}$	25	432	81.2	$\text{ZnCl}_2$
0	235	70.1	$\text{ZnCl}_2 \cdot \frac{1}{2}\text{H}_2\text{O}$	40	452	81.9	"
6.5	252	71.6	$\frac{1}{2}\text{H}_2\text{O} + \frac{1}{2}\text{H}_2\text{O}$	60	488	83.0	"
10	272	73.1	$\text{ZnCl}_2 \cdot \frac{1}{2}\text{H}_2\text{O}$	80	543	84.4	"
12.5	303	75.2	"	100	615	86.0	"
11.5	335	77.0	$\frac{1}{2}\text{H}_2\text{O} + \frac{1}{2}\text{H}_2\text{O}$	262	∞	100.0	"

### SOLUBILITY OF OXYCHLORIDES OF ZINC IN AQUEOUS SOLUTIONS OF ZINC CHLORIDE AT ROOM TEMPERATURE.

(Driot, 1910.)

Gms. per 100 Gms. $\text{H}_2\text{O}$ .		Solid Phase.	Gms. per 100 Gms. $\text{H}_2\text{O}$ .		Solid Phase.
$\text{ZnCl}_2$ .	$\text{ZnO}$ .		$\text{ZnCl}_2$ .	$\text{ZnO}$ .	
8.22	0.0137	$\text{ZnCl}_2 \cdot 4\text{ZnO} \cdot 6\text{H}_2\text{O}$	62.85	0.884	$\text{ZnCl}_2 \cdot 4\text{ZnO} \cdot 6\text{H}_2\text{O}$
23.24	0.138	"	96	1.792	"
45.95	0.497	"	124.7	3.213	"
51.5	0.604	"	144.8	2.64	"
56.9	0.723	"	203	1.59	$\text{ZnCl}_2 \cdot \text{ZnO} \cdot 1\text{H}_2\text{O}$

Results are also given for mixture of the oxychloride and oxide in aqueous zinc chloride solutions at various temperatures.



STABILITY OF ZINC CHLORIDE-AMMONIUM CHLORIDE MIXTURES IN WATER.  
(Meerburg, 1903.)

Isotherm for 0°.		Isotherm for 20°.			Isotherm for 30°.		
Gms. per 100 Gms. solution.	Solid Phase.	Gms. per 100 Gms. Solution.		Solid Phase.	Gms. per 100 Gms. Solution.		Solid Phase.
$\text{NH}_4\text{Cl}$ .		$\text{ZnCl}_2$ .	$\text{NH}_4\text{Cl}$ .		$\text{ZnCl}_2$ .	$\text{NH}_4\text{Cl}$ .	
22.8	$\text{NH}_4\text{Cl}$	0.0	26.9	$\text{NH}_4\text{Cl}$	0.0	29.5	$\text{NH}_4\text{Cl}$
23.0	"	5.1	27.1	"	9.2	29.4	"
23.5	"	9.5	27.4	"	16.0	29.7	"
23.9	"	12.7	27.5	"	20.2	30.1	"
24.7	"	15.7	27.7	"	24.7	30.4	"
25.3	"	18.0	27.9	"	26.3	30.8	$\text{NH}_4\text{Cl} + s$
26.0	"	23.5	29.0	"	27.2	30.2	$s$
26.1	"	26.0	29.5	$\text{NH}_4\text{Cl} + s$	30.1	29.6	$s$
26.3	$\text{NH}_4\text{Cl} + s$	29.5	28.1	$s$	36.8	28.2	"
26.4	$s$	32.3	27.7	"	42.4	27.3	"
25.7	"	35.8	27.0	"	43.8	27.3	$s + b$
25.3	"	38.7	26.9	"	45.0	24.4	$b$
24.4	"	40.2	26.6	"	51.2	17.6	"
24.6	$s + b$	41.9	26.3	"	61.9	10.4	"
21.3	$b$	43.2	26.0	$s + b$	66.9	9.2	$\text{ZnCl}_2 + b$
15.3	"	46.9	21.0	$b$	75.6	6.1	$\text{ZnCl}_2$
11.9	"	53.2	14.5	"	70.3	7.6	"
10.0	"	58.4	11.1	"	78.5	3.2	"
7.5	"	62.7	8.7	"	76.9	3.5	"
6.8	"	66.6	7.9	"	79.8	1.6	"
					81.6	0.0	"

$s = \text{ZnCl}_2 \cdot 3\text{NH}_4\text{Cl}$ .  $b = \text{ZnCl}_2 \cdot 2\text{NH}_4\text{Cl}$ .

- 100 gms. abs. acetone dissolve 43.5 gms.  $\text{ZnCl}_2$  at 18°,  $d_{18}$  of sat. sol. = 1.14.  
(Naumann, 1904.)  
100 gms. glycerol dissolve 50 gms.  $\text{ZnCl}_2$  at 15.5°. (Ossendowski, 1907.)  
100 cc. anhydrous hydrazine dissolve 8 gms.  $\text{ZnCl}_2$  at room temp.  
(Weh and Broderick, 1915.)  
When 1 gm. of zinc as chloride is dissolved in 100 cc. of aq. 10% HCl and shaken with 100 cc. of ether, 0.03 per cent of the metal enters the ethereal layer.  
(Mylus, 1911.)

## CHROMATES.

### EQUILIBRIUM IN THE SYSTEM ZINC OXIDE, CHROMIUM TRIOXIDE AND WATER AT 25°.

(Gröger, 1911.)

When excess of  $\text{ZnO}$  was, in each case, shaken for 3 days at 25°, with gradually increasing concentrations of chromic acid.

Gms. per Liter Sat. Sol.		Solid Phase.	Gms. per Liter Sat. Sol.		Solid Phase.
$\text{ZnO}$ .	$\text{CrO}_3$ .		$\text{ZnO}$ .	$\text{CrO}_3$ .	
40.9	0.604	$4\text{ZnO} \cdot \text{CrO}_3 \cdot 3\text{H}_2\text{O}$	66.1	151	$4\text{ZnO} \cdot \text{CrO}_3 \cdot 3\text{H}_2\text{O}$
24	4.19	"	83.7	192	" + $3\text{ZnO} \cdot 2\text{CrO}_3 \cdot \text{H}_2\text{O}$
86	11.5	" + $3\text{ZnO} \cdot \text{CrO}_3 \cdot 2\text{H}_2\text{O}$	123	285	$3\text{ZnO} \cdot 2\text{CrO}_3 \cdot \text{H}_2\text{O}$
7	22.2	$3\text{ZnO} \cdot \text{CrO}_3 \cdot 2\text{H}_2\text{O}$	193	450	"
7	57.5	"	196	461	" + $\text{ZnO} \cdot \text{CrO}_3 \cdot \text{H}_2\text{O}$
4	66.7	" + $4\text{ZnO} \cdot \text{CrO}_3 \cdot 3\text{H}_2\text{O}$	202	475	$\text{ZnO} \cdot \text{CrO}_3 \cdot \text{H}_2\text{O}$
2	70.6	$4\text{ZnO} \cdot \text{CrO}_3 \cdot 3\text{H}_2\text{O}$	389	940	"



**ZINC CINNAMATE**

752

**ZINC CINNAMATE**  $\text{Zn}(\text{C}_6\text{H}_5\text{CH}:\text{CHCOO})_2$ .

100 cc. sat. solution in water contain 0.144 gm. zinc cinnamate at 26.5°.

(De Jong, 1909.)

**ZINC CYANIDE**  $\text{Zn}(\text{CN})_2$ .100 cc. concentrated  $\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2$  + Aq. dissolve 0.4 gm.  $\text{Zn}(\text{CN})_2$ .100 cc. concentrated  $\text{ZnSO}_4$  + Aq. dissolve 0.2 gm. (Joannis, 1881.)100 gms.  $\text{H}_2\text{O}$  dissolve 0.24 gm. zinc mercuric thiocyanate,  $\text{ZnHg}(\text{CNS})_2$  at 15°.

(Robertson, P. W., 1907.)

**ZINC FLUORIDE**  $\text{ZnF}_2 \cdot 4\text{H}_2\text{O}$ .

One liter of water dissolves 16 gms. at 18°.

(Dietz, 1900.)

**ZINC HYDROXIDE**  $\text{Zn}(\text{OH})_2$ .One liter of water dissolves 0.0042 gm.  $\text{ZnO}$  at 18°, conductivity method.

(Dupre and Bialas, 1903.)

One liter of water dissolves 0.01 gm. at 25°.

(Bodländer, 1898.)

## SOLUBILITY OF ZINC HYDROXIDE IN AQUEOUS SOLUTIONS OF:

## Ammonia and Ammonia Bases at 17°-19°.

(Herz, 1902.)

## Sodium Hydroxide at Ord. Temp.

(Rubenbauer, 1902.)

Normality of the Base.	Normality of Dis- solved Zn.	Gms. ZnO per 20 cc. Solution.	Gms. per 20 cc. Solution		Mol. Dilution of the NaOH.
			Na.	Zn.	
0.0942 $\text{NH}_3$	0.0011	0.00185	0.1012	0.0040	4.50
0.236 "	0.0110	0.0180	0.1978	0.0150	2.33
0.707 "	0.059	0.0958	0.4278	0.0442	1.06
0.0944 $\text{NH}_2\text{CH}_3$	0.0005	0.0008	0.6670	0.1771	0.70
0.472 "	0.0081	0.0132	0.9660	0.9630	0.48
0.944 "	0.03	0.0484	1.4951	0.2481	0.31
0.068 $\text{NH}_2\text{C}_2\text{H}_5$	0.0003	0.0005	2.9901	0.3700	0.16
0.51 "	0.0045	0.0074	Moist Zn (OH) <sub>2</sub> used. So- lutions shaken 5 hours.		
0.68 "	0.0098	0.0161			

## SOLUBILITY OF ZINC HYDROXIDE IN AQUEOUS SOLUTIONS OF AMMONIUM HYDROXIDE.

## Results of Euler (1903).

## Results of Bonsdorff (1904) at 25°.

t°.	Normality of Aq. Ammonia.	Mols. Zn per Liter.	Normality of Aq. Ammonia.	Gms. ZnO per Liter.	Normality of Aq. Ammonia.	Gms. ZnO per Liter.
15-17	0.485	0.013-0.010*	0.311	0.85	0.321	0.34
15-17	0.97	0.034	0.825	3.84	0.643	0.845
21	0.253	0.0029	1.287	7.28	1.215	2.70
21	0.259	0.0022*			1.928	5.07
21	0.500	0.0097			2.570	7.01
21	0.518	0.0070			3.213	10.16

Euler states that the higher results of Herz are due to incompletely purified zinc hydroxide and uses material precipitated from the nitrate for his experiments. Different preparations of  $\text{Zn}(\text{OH})_2$  containing from 55 to 77 per cent  $\text{H}_2\text{O}$  were used and in the two cases marked \*  $\text{ZnO}$  was used.

Bonsdorff used for his second series of determinations,  $\text{Zn}(\text{OH})_2$  precipitate from the nitrate and brought in moist condition into the ammonia solutions.



**SOLUBILITY OF ZINC HYDROXIDE IN AQUEOUS POTASSIUM HYDROXIDE SOLUTIONS.**

(Klein, 1912.)

The determinations were made by adding aq.  $\text{ZnSO}_4$  solution (containing one m. mol. per liter) to aq. KOH solutions until a permanent precipitate just appeared. The titrations are also recalculated to mols. per liter and correction made for the dilution of the KOH solution by the aq.  $\text{ZnSO}_4$ .

Normality of Aq. KOH.	cc. $\text{ZnSO}_4$ Sol. per 50 cc. Aq. KOH.	Calculated Mols. per Liter of Sat. Sol.		
		Orig Conc. KOH.	Corrected Conc. of KOH.	Conc. of Zn.
1	5.5	1	0.9	0.10
1.78	13.1	1.78	1.42	0.209
2	14.3	2	1.56	0.223
2.22	17.0	2.22	1.63	0.266
2.5	18.8	2.5	1.81	0.272
3	24.6	3	2.02	0.330
3.6	29.1	3.6	2.28	0.368
4	34	4	2.38	0.405
6	56 (?)	6	2.78	0.540

**SOLUBILITY OF ZINC HYDROXIDE IN ONE PER CENT AQUEOUS SALT SOLUTIONS AT 16°-20°.**

(Snyder, 1878.)

The  $\text{CO}_2$  free  $\text{Zn(OH)}_2$  dissolved is calculated as milligrams Zn per liter of the given salt solution. Additional determinations are also given.

Aq. Salt Solution.	Mgs. Zn per Liter Solution.	Aq. Salt Solution.	Mgs. Zn per Liter Solution.	Aq. Salt Solution.	Mgs. Zn per Liter Solution.
NaCl	51	$\text{K}_2\text{SO}_4$	37.5	$\text{K}_2\text{CO}_3$	0
KCl	43	$\text{MgSO}_4$	27	$\text{NH}_4\text{Cl}$	95
$\text{CaCl}_2$	57.5	$\text{KNO}_3$	17.5	$\text{NH}_4\text{NO}_3$	77
$\text{MgCl}_2$	65	$\text{Ba(NO}_3)_2$	25	$(\text{NH}_4)_2\text{SO}_4$	88
$\text{BaCl}_2$	38				

**ZINC IODATE  $\text{Zn(IO}_3)_2$ .**

100 gms.  $\text{H}_2\text{O}$  dissolve 0.87 gm.  $\text{Zn(IO}_3)_2$  cold and 1.31 gms. hot.

(Rammelsberg, 1838.)

**ZINC IODIDE  $\text{ZnI}_2$ .**

**SOLUBILITY IN WATER.**

(Diets, 1900; see also Etard, 1894.)

t°.	Gms. $\text{ZnI}_2$ per 100 Gms. Solution.	Mols. $\text{ZnI}_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{ZnI}_2$ per 100 Gms. Solution.	Mols. $\text{ZnI}_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
-10	80.50	23.3	$\text{ZnI}_2 \cdot \text{H}_2\text{O}$	0	81.11	24.2	$\text{ZnI}_2$
-5	80.77	23.7	"	18	81.20	24.4	"
0	81.16	24.3	"	40	81.66	25.1	"
+10	82.06	25.8	"	60	82.37	26.4	"
22	83.12	27.8	"	80	83.05	27.5	"
27	89.52	50.3	"	100	83.62	28.7	"

Sp. Gr. of sat. solution of the anhydrous salt at 18° = 2.725.

100 gms. glycerol dissolve 40 gms.  $\text{ZnI}_2$  at 15.5°.

(Ossendowski, 1907.)



# ZINC NITRATE

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## ZINC NITRATE $\text{Zn}(\text{NO}_3)_2$ .

### SOLUBILITY IN WATER.

(Funk, 1900.)

t°.	Gms. $\text{Zn}(\text{NO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{ZnNO}_3$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.	t°.	Gms. $\text{Zn}(\text{NO}_3)_2$ per 100 Gms. Solution.	Mols. $\text{Zn}(\text{NO}_3)_2$ per 100 Mols. $\text{H}_2\text{O}$ .	Solid Phase.
-25	40.12	6.36	$\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	18	53.50	10.9	$\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
-22.5	40.75	6.54	"	25	55.90	12.0	"
-20	42.03	6.89	"	36.4	63.63	16.7	"
-18	43.59	7.34	"	36	64.63	17.4	"
-18	44.63	7.67	$\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	33.5	65.83	18.3	"
-15	45.26	7.86	"	37	66.38	18.8	$\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$
-13	45.51	7.94	"	40	67.42	19.7	"
-12	45.75	8.01	"	41	68.21	20.4	"
0	48.66	9.01	"	43	69.26	21.4	"
+12.5	52.0	10.3	"	45.5	77.77	33.3	"

## ZINC OXALATE $\text{ZnC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ .

One liter  $\text{H}_2\text{O}$  dissolves 0.0057 gm.  $\text{ZnC}_2\text{O}_4$  at  $9.76^\circ$ , 0.0064 gm. at  $17.92^\circ$  and 0.00715 gm. at  $26.15^\circ$ . (Kohlrausch, 1908.)

### SOLUBILITY OF ZINC OXALATE IN AQUEOUS AMMONIUM OXALATE SOLUTIONS AT $25^\circ$ .

(Kunschert, 1904.)

Mol. Normal $(\text{NH}_4)_2\text{C}_2\text{O}_4$	0.05	0.10	0.15	0.20	0.25
Mol. Zn per Liter	0.0022	0.0055	0.01055	0.0174	0.0257

Complex ammonia zinc oxalates are formed. When more than 0.15 free oxalate is present the complex has the formula,  $(\text{NH}_4)_4\text{Zn}(\text{C}_2\text{O}_4)_3$ . In the more dilute solutions it has the composition,  $(\text{NH}_4)_2\text{Zn}(\text{C}_2\text{O}_4)_2$ .

## ZINC Ammonium PHOSPHATE $\text{ZnNH}_4\text{PO}_4$ .

One liter sat. solution in water contains 0.0136 gm.  $\text{ZnNH}_4\text{PO}_4$  at  $10.5^\circ$  and 0.0145 gm. at  $17.5^\circ$ . (Artmann, 1915.)

## ZINC SULFATE $\text{ZnSO}_4$ .

### SOLUBILITY IN WATER.

(Cohen, 1900; at  $50^\circ$ ; Callender and Barnes, 1897; Etard, 1894; Poggiale, 1843; Mulder.)

t°.	Gms. $\text{ZnSO}_4$ per 100 Gms. Solution.	Gms. $\text{ZnSO}_4$ per 100 Gms. Water.	Solid Phase.	t°.	Gms. $\text{ZnSO}_4$ per 100 Gms. Solution.	Gms. $\text{ZnSO}_4$ per 100 Gms. Water.	Solid Phase.
-5	28.21	39.30	$\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$	25	38.94	63.74	$\text{ZnSO}_4 \cdot 6\text{H}_2\text{O}$
0.1	29.54	41.93	"	39	41.22	70.06	$6\text{H}_2\text{O} + 7\text{H}_2\text{O}$
9.1	32.01	47.09	"	50	43.45	76.84	$\text{ZnSO}_4 \cdot 6\text{H}_2\text{O}$
15	33.81	50.88	"	70	47.5	88.7	$6\text{H}_2\text{O} + \text{H}_2\text{O}$
25	36.67	57.90	"	80	46.4	86.6	$\text{ZnSO}_4 \cdot \text{H}_2\text{O}$
35	39.98	66.61	"	90	45.5	83.7	"
39	41.21	70.05	"	100	44.7	80.8	"
-5	32.00	47.08	$\text{ZnSO}_4 \cdot 6\text{H}_2\text{O}$	120	41.7	71.5	"
01	33.09	49.48	"	140	38.0	61.3	"
				160	33.0	49.3	"

The Sp. Gr. of a sat. sol. of  $\text{ZnSO}_4$  in water at  $15^\circ$  is 1.452. (Greenish and Smith, 1902.)

Data for the solubility of  $\text{ZnSO}_4$  in water at high pressures are given by Cohen and Sinnige (1909, 1910.)



LIQUIDITY OF ZINC SULFATE—SODIUM SULFATE MIXTURES IN WATER.  
(Koppel, Gumpert, 1905.)

Gms. per 100 Gms. Solution.		Gms. per 100 Gms. H <sub>2</sub> O.		Mols. per 100 Mols. H <sub>2</sub> O.		Solid Phase.
ZnSO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	ZnSO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	ZnSO <sub>4</sub> .	Na <sub>2</sub> SO <sub>4</sub> .	
19	5.33	40.30	7.90	4.50	1.01	} ZnSO <sub>4</sub> ·7H <sub>2</sub> O + Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O
85	6.27	42.28	9.52	4.71	1.21	
58	15.63	26.32	23.40	2.94	2.96	ZnNa <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·4H <sub>2</sub> O
66	15.58	26.47	23.44	2.95	2.97	"
59	15.70	26.36	23.52	2.94	2.98	"
75	15.72	26.68	23.63	2.98	2.99	"
16	7.16	45.79	11.24	5.11	1.42	} ZnNa <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·4H <sub>2</sub> O + ZnSO <sub>4</sub> ·7H <sub>2</sub> O
70	6.40	48.81	10.17	5.45	1.29	
51	5.36	52.34	8.62	5.84	1.09	
36	4.41	56.15	7.22	6.27	0.91	
28	3.80	60.55	6.34	6.76	0.81	} ZnNa <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·4H <sub>2</sub> O + ZnSO <sub>4</sub> ·6H <sub>2</sub> O
18	3.30	65.25	5.64	7.28	0.71	
83	2.90	66.64	4.98	7.44	0.63	} ZnNa <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·4H <sub>2</sub> O + Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O
26	2.78	64.89	4.71	7.24	0.60	
91	7.92	43.50	12.34	4.85	1.565	} ZnNa <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·4H <sub>2</sub> O + Na <sub>2</sub> SO <sub>4</sub> ·10H <sub>2</sub> O
28	10.90	36.92	16.71	4.12	2.12	
14	14.58	28.77	21.95	3.21	2.79	
31	19.94	19.93	29.87	2.22	3.785	
96	27.75	10.67	42.51	1.19	5.39	} ZnNa <sub>2</sub> (SO <sub>4</sub> ) <sub>2</sub> ·4H <sub>2</sub> O + Na <sub>2</sub> SO <sub>4</sub>
61	30.03	8.72	46.61	0.971	5.91	
96	28.65	9.16	43.83	1.02	5.555	

SOLUBILITY OF ZINC SULFATE IN AQUEOUS ETHYL ALCOHOL.  
(Schiff, 1861.)

Concentration of Alcohol	10 per cent	20 per cent	40 per cent
O <sub>4</sub> ·7H <sub>2</sub> O per 100 Gms. Solution	51.1	39	3.45

1. abs. methyl alcohol dissolve 0.65 gm. ZnSO<sub>4</sub> at 18°, 5.90 gms. ZnSO<sub>4</sub>·7H<sub>2</sub>O at 18°.

2. 50 per cent methyl alcohol dissolve 15.7 gms. ZnSO<sub>4</sub>·7H<sub>2</sub>O at 18°.  
(de Bruyn, 1892.)

3. glycerol dissolve 35 gms. zinc sulfate at 15.5°. (Ossendowski, 1907.)

**LIQUIDITY** ZnS.

1. 100 gms. H<sub>2</sub>O dissolves 70.6·10<sup>-4</sup> mols. ZnS = 0.0069 gm. at 18°, determined by conductivity method, assuming complete dissociation and hydrolysis.

(Weigel, 1906, 1907.)

**LIQUIDITY** ZnSO<sub>4</sub>·2H<sub>2</sub>O.

1. H<sub>2</sub>O dissolve 0.16 gm. ZnSO<sub>4</sub>·2H<sub>2</sub>O. (Houston and Trichborne, 1890.)

**LIQUIDITY** ZINCONATES

SOLUBILITY IN WATER.

Name.	Formula.	Sp.	Gms. Anhy. Salt per 100 Gms. H <sub>2</sub> O.	Authority.
Phthalene Sulfonate	(C <sub>10</sub> H <sub>7</sub> .SO <sub>3</sub> ) <sub>2</sub> Zn·6H <sub>2</sub> O	25	0.45	(Witt, 1915.)
Benanthrene	(C <sub>14</sub> H <sub>9</sub> .SO <sub>3</sub> ) <sub>2</sub> Zn·6H <sub>2</sub> O	20	0.083	(Sandquist, '12.)
"	(C <sub>14</sub> H <sub>9</sub> .SO <sub>3</sub> ) <sub>2</sub> Zn·4H <sub>2</sub> O	20	0.19	"
"	(C <sub>14</sub> H <sub>9</sub> .SO <sub>3</sub> ) <sub>2</sub> Zn·6H <sub>2</sub> O	20	0.15	"



## ZINC SULFONATES

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SOLUBILITY OF ZINC PHENOLSULFONATE,  $p$  ( $C_6H_4.OH.SO_3$ ) $_2$ Zn.8H $_2$ O, IN AQUEOUS ALCOHOL SOLUTIONS AT 25°.  
(Seidell, 1910.)

Wt. % C <sub>6</sub> H <sub>5</sub> OH in Solvent.	d <sub>m</sub> of Sat. Sol.	Gms. (C <sub>6</sub> H <sub>5</sub> OH- SO <sub>3</sub> ) $_2$ Zn.8H $_2$ O per 100 Gms. Sat. Sol.	Wt. % C <sub>6</sub> H <sub>5</sub> OH in Solvent.	d <sub>m</sub> of Sat. Sol.	Gms. (C <sub>6</sub> H <sub>5</sub> OH- SO <sub>3</sub> ) $_2$ Zn.8H $_2$ O per 100 Gms. Sat. Sol.
0	1.185	39.8	80	1.057	40.7
20	1.161	40.7	90	1.047	41.4
40	1.139	42.1	92.3	1.048	41.9
47	...	42.2	95	1.052	42.9
60	1.106	41.6	100	1.075	48.8

100 gms. H $_2$ O dissolve 37 gms. (C<sub>6</sub>H<sub>4</sub>.OH.SO $_3$ ) $_2$ Zn.8H $_2$ O at 15° and d<sub>m</sub> of sat. sol. = 1.162.  
(Greenish and Smith, 1902.)

## ZINC TARTRATE C<sub>4</sub>H<sub>4</sub>O<sub>6</sub>.Zn.2H $_2$ O.

SOLUBILITY IN WATER.  
(Cantoni and Zachoder, 1905.)

t°.	Gms. C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> .Zn.2H $_2$ O per 100 cc. Solution.	t°.	Gms. C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> .Zn.2H $_2$ O per 100 cc. Solution.	t°.	Gms. C <sub>4</sub> H <sub>4</sub> O <sub>6</sub> .Zn.2H $_2$ O per 100 cc. Solution.
15	0.019	40	0.060	65	0.100
20	0.022	45	0.073	70	0.088
25	0.036	50	0.087	75	0.078
30	0.041	55	0.116	80	0.059
35	0.055	60	0.104	85	0.041

## ZINC VALERATE Zn(C<sub>4</sub>H<sub>7</sub>COO) $_2$ .2H $_2$ O.

SOLUBILITY OF ZINC VALERATE IN AQUEOUS ALCOHOL SOLUTIONS AT 25°.  
(Seidell, 1910.)

Wt. % C <sub>4</sub> H <sub>7</sub> OH in Solvent.	d <sub>m</sub> of Sat. Sol.	Gms. Zn(C <sub>4</sub> H <sub>7</sub> - COO) $_2$ .2H $_2$ O per 100 Gms. Sat. Sol.	Wt. % C <sub>4</sub> H <sub>7</sub> OH in Solvent.	d <sub>m</sub> of Sat. Sol.	Gms. Zn(C <sub>4</sub> H <sub>7</sub> - COO) $_2$ .2H $_2$ O per 100 Gms. Sat. Sol.
0	1.004	1.44	85	0.836	2.15
20	0.972	0.75	90	0.827	3.20
40	0.936	0.76	92.3	0.828	5.50
60	0.894	1.15	95	0.832	8.80
80	0.848	1.70	100	0.844	15.60

## ZIRCONIUM SULFATE Zr(SO $_4$ ) $_2$ .

SOLUBILITY OF ZIRCONIUM SULFATE IN AQUEOUS SULFURIC ACID AT 37.5°.  
(Hauser, 1907.)

Gms. per 100 Gms. Sat. Sol.		Solid Phase.	Gms. per 100 Gms. Sat. Sol.		Solid Phase.
ZrO $_2$ .	SO $_3$ .		ZrO $_2$ .	SO $_3$ .	
19.5	25.46	Zr(SO $_4$ ) $_2$ .4H $_2$ O	0.15	56.7	Zr(SO $_4$ ) $_2$ .4H $_2$ O
18.8	27	"	0.50	57.5	"
16.2	29.1	"	2	59.5	"
9.6	32.3	"	4.4	61.4	" + Zr(SO $_4$ ) $_2$ .H $_2$ SO $_4$ .3H $_2$ O
5.3	34.7	"	4.55	61.5	Zr(SO $_4$ ) $_2$ .H $_2$ SO $_4$ .3H $_2$ O
3.51	36.01	"	3.33	63.8	"
1.03	38.2	"	1.80	64.2	"
0.46	39.8	"	1.12	66.8	"
0.33	42.1	"	0.96	68.4	"
0.14	46.8	"	0.10	81.5	Zr(SO $_4$ ) $_2$ .H $_2$ SO $_4$ .H $_2$ O

Results at 22° show only slight differences from the above figures, hence, the temperature coefficient for this salt is quite small. In an earlier paper Hauser (1905) gives data for the basic sulfate 4ZrO $_2$ .3SO $_3$ .14H $_2$ O.



## METHODS FOR THE DETERMINATION OF SOLUBILITY

A quantitative determination of a solubility consists essentially of two operations; the preparation of the saturated solution and its subsequent analysis. In those cases where these steps are performed separately the method may, in general, be designated as the analytical and in those where they are combined, as the synthetic. In both cases, however, the consideration of first importance is the assurance that final equilibrium between solvent and solute has been reached. Since this point is that at which no further change occurs in the relation between the amount of the compound in solution and that remaining undissolved, the only criterion of saturation is the evidence that the concentration of the solution has not changed during a longer or shorter interval of time, during which those conditions which would tend to promote such a change have been allowed to operate.

Of the conditions which promote most effectively the attainment of equilibrium between a solute and a solvent, the provision for the intimate contact of the two is most important. In other words, only by the thorough mixing which agitation or effective stirring provides can the point of saturation be reached with certainty. In the case of the reciprocal solubility of liquids, the point of equilibrium is usually attained within a much shorter period than in the case of solids dissolved in liquids. In the latter case, the necessary integration of the solid, incident to its solution in the liquid, is a process which is restricted to the surface layers of the solid, and, therefore, unless a large area, such as a finely divided state provides, is available, and unless that portion of the solvent which has acted upon a given surface area is repeatedly replaced by fresh solvent, the process of solution will be greatly retarded. It is quite evident that, although a solution in contact with even very finely divided solid may promptly become saturated in the immediate vicinity of the solid without stirring, the distribution of the dissolved material to the remainder of the solvent would depend upon diffusion, and hence the rate at which this proceeds would diminish as the concentration differences became equalized, the process would take place



## METHODS FOR THE DETERMINATION OF SOLUBILITY

at a gradually diminishing rate. If the point of equilibrium is approached from supersaturation, the above remarks apply with equal effect, since only at the surface of the solid can the excess of salt leave the solution and, without other provision than diffusion for successively bringing the entire amount of the solution in contact with the solid, the deposition of the excess of dissolved material can occur only at a very slow rate. The importance of active and continuous agitation of the solid and solution, in effecting saturation, cannot, therefore, be too strongly emphasized. It may in fact be assumed that determinations of the solubility of solids, made without continuous agitation, are always open to the suspicion that the results do not represent the final equilibrium which such data are required to show.

Since solubility is a function of temperature, the accurate control of the temperature in making a solubility determination is another one of the indispensable requisites of accuracy. In general, it may be stated therefore, that every procedure designed for preparing a saturated solution must include provision for the accurate control of the temperature and for active and continuous agitation or stirring of the solution. In the case of the solubility of gases, which will be considered in a separate section, provision for the control of the pressure must also be made.

It is obvious that since the solubilities of various compounds differ, and that of one compound is affected by the presence of another, the accurate determination of this constant for a particular molecular species presupposes that only this one substance is present in the pure solvent. That is, accuracy of results demand that only pure compounds be involved in a given determination, consequently, no effort should be spared to make it certain that the highest possible purity of both solute and solvent has been attained.

*Apparatus for the Determination of the Solubility of Solids by the Analytical Method.*—The types of apparatus which have been developed for the preparation of saturated solutions of solids in liquids differ principally in respect to whether designed for multiple or single determinations at a given temperature. Examples of the first type are illustrated by Figs. 1 and 2.

It will be noted that in the one case (Fig. 1) the bottles containing the solutions are stationary and the liquid in each and in the constant temperature bath is kept in motion by means of revolving stirrers. This form of apparatus was used by Moody and Leyson (1908) for the determination of the solubility of lime in water and is particularly adapted for relatively slightly soluble compounds for



METHODS FOR THE DETERMINATION OF SOLUBILITY

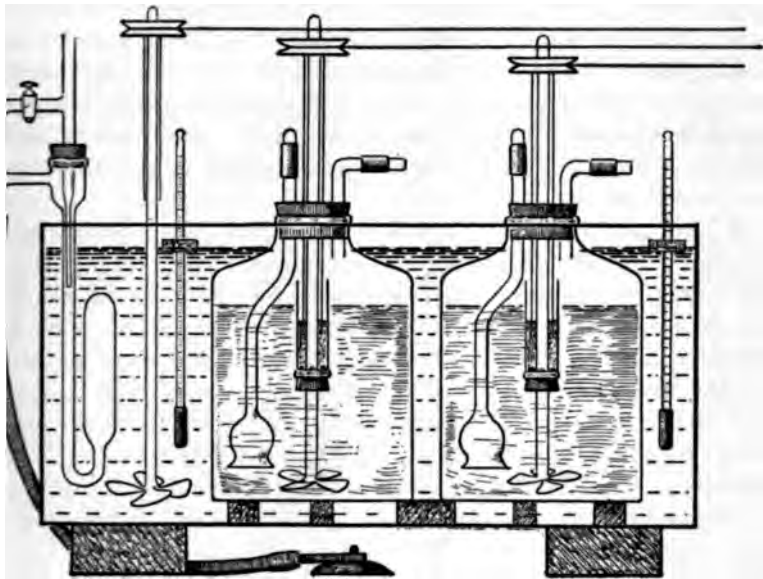


FIG. 1.

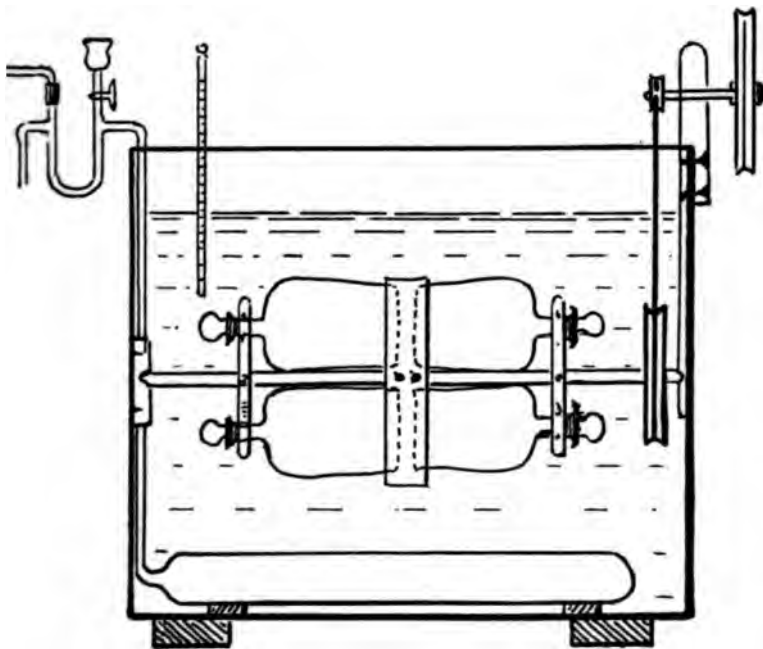


FIG. 2.



## METHODS FOR THE DETERMINATION OF SOLUBILITY

which rather large quantities of the saturated solution are needed for accurate analysis. There is also shown in the figure the provision for withdrawing the saturated solution through a filter within the inverted thistle tube. The stirrers in the bottles are fitted with mercury seals to prevent access of air containing carbon dioxide. Other features of the apparatus will be readily understood from the drawing.

A more common type of apparatus, designed for the simultaneous saturation of several solutions at the same temperature, is that illustrated by Fig. 2, in which the bottles containing the solutions are slowly rotated in the constant temperature bath. The form shown is that described by Noyes (1892). This type of apparatus has the advantage that the solid is, to a large extent, kept in suspension in the liquid and, therefore, offers the most favorable opportunity for continuous and uniform contact with the solution. Many examples of this form of apparatus, differing principally in size and in the direction of movement of the containers, are described in the literature.

Of the second type of apparatus, designed for a single determination at a given temperature, many varieties have been developed for particular conditions. Of these, the following examples have been selected as typical of this class and, it is hoped, will illustrate most of their desirable features. They are, in general, adaptations of earlier designs and it is not intended that the name given in connection with each is that of the investigator who deserves the credit for originating the type. The drawings will, for the most part, be readily understood without detailed explanations. The dimensions are not stated, since they can usually be varied to suit the needs of almost any problem.

In Fig. 3 is shown the apparatus used by the Earl of Berkeley (1904) for the very careful determinations of the solubility of inorganic salts in water. The features of particular interest in connection with it are, that the water bath itself is made to serve as the temperature regulating device, and the apparatus for withdrawing and simultaneously filtering the saturated solution is a combination of pipet and pycnometer. This was provided with ground glass caps for each end and the stem was accurately graduated. It was, of course, carefully standardized before use. The flexible iron plate shown was made of a disc from the receiver of a telephone. The apparatus was used for determinations at temperatures between  $30^{\circ}$  and  $90^{\circ}$  and the range of variations from the set temperature of the bath was, for 2-3 hour periods, within



## METHODS FOR THE DETERMINATION OF SOLUBILITY

but  $0.2^{\circ}$ . For the inner vessel containing the salt, the range is about  $0.05^{\circ}$ . At each temperature two determinations of density and solubility were made; one on the solution obtained by stirring a supersaturated solution in contact with solid salt, and another on the solution obtained by stirring an unsaturated solution in contact with an excess of salt.

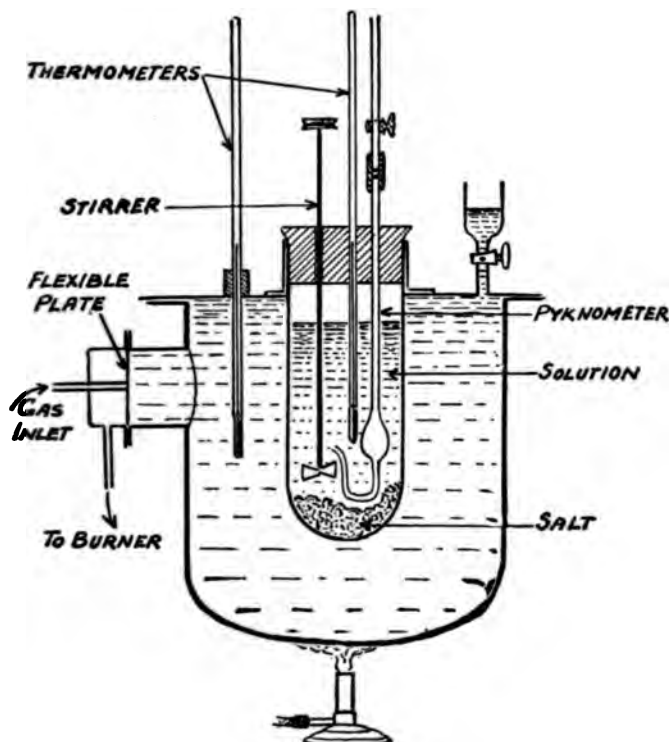


FIG. 3.

In the case of determinations at the boiling point a special apparatus was required. Two forms, described by the Earl of Berkeley (1904), are shown in Figs. 4 and 5. The first was used for the less soluble salts and consisted of an outer tube *A* containing water and an inner tube *B* containing salt and solution. By boiling the water vigorously and closing the side tube *C*, steam rising through the tube *D* stirred the solution thoroughly and the temperature rose to the boiling point of the saturated solution, which remained constant when saturation was attained. The second form of apparatus (Fig. 5) was devised for use with extremely



## METHODS FOR THE DETERMINATION OF SOLUBILITY

soluble salts. In these cases it was found that the larger quantity of steam required for thorough stirring dissolved so much salt that it was necessary to have a very large excess present. In this apparatus the steam was generated in a boiler *A* and conducted through the tube *B* to the bottom of the large test tube *C* containing the excess of salt and solution. The test tube was immersed in the oil

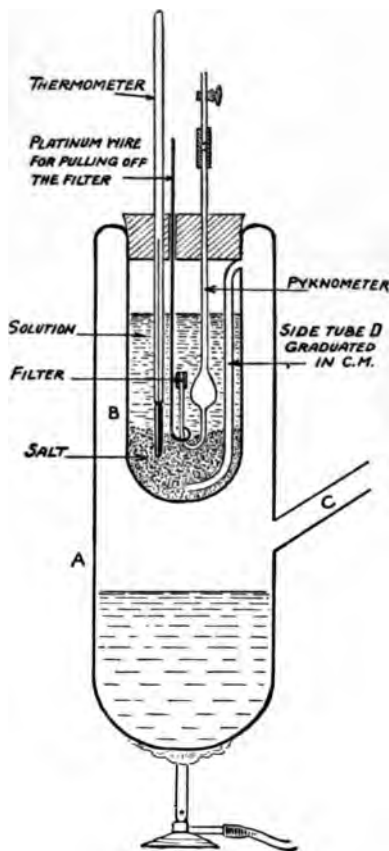


FIG. 4.

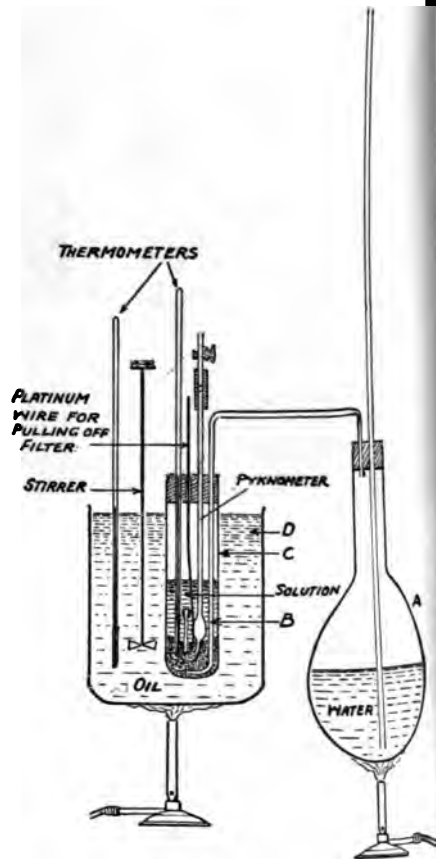


FIG. 5.

bath *D* which was vigorously stirred and maintained at a temperature close to that of the boiling point of the saturated solution. When the temperature of the oil bath was below the boiling point, salt dissolved; when above, salt was thrown out of solution. Considerable difficulty was experienced in filling the pycnometer with the saturated solution without introducing errors due to steam bubbles caused by the suction which was applied.



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comparatively simple form of the type of apparatus used by Meyer in 1875 and modified by Reicher and van Deventer (1895), is described by Hicks (1915) and is shown in the accompanying Fig. 6. A glass cylinder *A* is closed at

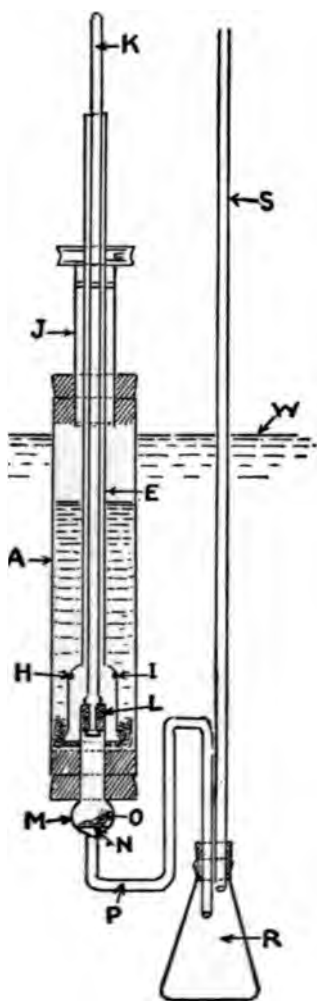


FIG. 6.

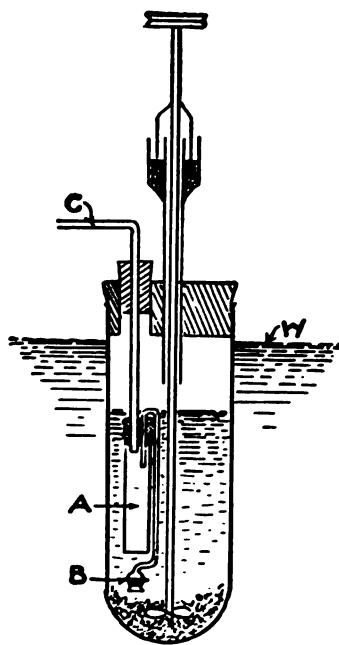


FIG. 7.

end with large one-hole rubber stoppers. The mixture of salt solution is contained in this cylinder and is stirred by the rotation of the tube *E* which is provided with an enlargement at its lower end in which there are two small holes at *H* and *I*. The



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stirrer rotates in the bearing formed by the hollow wooden cylinder *J*. The glass rod *K* carries a rubber stopper *L* which closes the filtering tube *M*, in which a platinum cone *N* supports an asbestos filter *O*. The siphon *P* connects the filtering tube with the flask *R* which is provided with an outlet through the small tube *S*. The apparatus is immersed in a constant temperature water bath *W*, to about the level shown. After stirring the mixture of salt and solution a sufficient length of time for attainment of saturation, the undissolved salt is allowed to settle and the rubber stopper is withdrawn from the filter tube by means of the glass rod *K*. Suction is applied through the tube *S* to hasten the filtering and the clear solution collected, at the temperature of the bath, in the previously weighed flask *R*.

A similar apparatus was used by Walton and Judd (1911), for determination of the solubility of lead nitrate in pyridine. This is shown in Fig. 7 and consists of a glass test tube fitted with a stirrer which turns in a mercury seal, thus preventing loss of solvent by evaporation or the admission of moisture from the air. To take a sample of the saturated solution, the weighing tube *A* was introduced into the larger tube through a hole in the stopper. After reaching the temperature of the bath the stirrer was stopped, the end of the small tube *B*, which was covered with a piece of closely-woven muslin, was dipped below the surface of the solution and the liquid drawn into *A* by applying suction at *C*. The tube *A* was then removed, weighed and the contents analyzed.

An apparatus which was used by Donnan and White (1911), for the determination of equilibrium in the system palmitic acid and sodium palmitate is shown in Fig. 8. The stirring in this case was accomplished by means of a current of dry air, free of carbon dioxide. The apparatus consists of two parts, namely, an inner chamber *E*, where equilibrium was attained, and an outer case *A*, designed for isothermal filtration. The whole was immersed in a thermostat to the level *W*. A side tube *B* permitted connection with a filter pump. *C* is a weighing bottle to receive the filtered saturated solution and *D* a Gooch crucible provided with a paper filter. The cork, closing *A*, was covered with a plastic layer to render it air-tight. The tube at the lower end of *E* was closed with a ground glass plug *F*, the stem of which was enlarged to a small bulb at *G* and then drawn out to pass easily through *H*, leaving an air free outlet around it. The small cork *I* was used to support the stopper when lifted to allow the contents of *E* to flow down for filtration. The dry air by which the mixture was



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It was drawn through *K* by applying suction at *H*. The heating of this air was accomplished by drawing it through a spiral immersed in the thermostat. The connection between equilibrium apparatus and preheater was made through a dry seal, which permitted lifting the apparatus easily without going to the fragile preheater permanently mounted in the

This apparatus provided for the recovery, separately, of

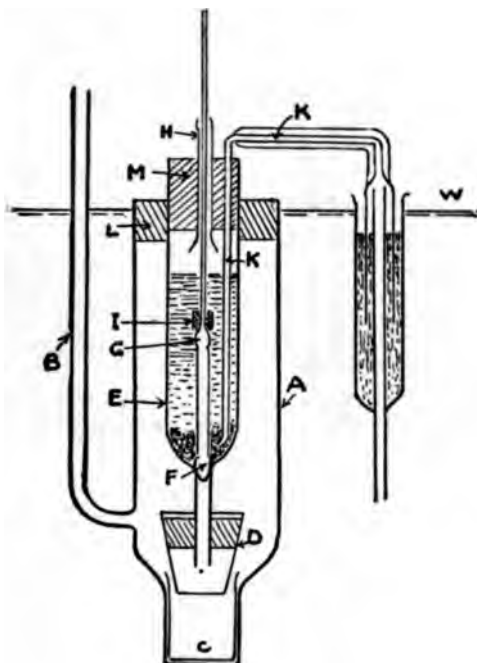


FIG. 8.

saturated solution and undissolved solid. These authors also describe an improved electrically heated and controlled constant temperature bath.

Measurements at lower temperatures than can be constantly maintained with the aid of a water bath require special forms of apparatus which permit of temperature control under more or less restricted conditions. An apparatus of this type, which was described by Cohen and Inouye (1910), for determination of the solubility of phosphorus in carbon disulfide, is shown in Fig. 9, and is intended for the range of temperature between  $-10^{\circ}$  and  $+10^{\circ}$ . The saturating vessel *D* consists of a glass cylinder to the upper



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end of which is cemented a steel collar *E*, containing a deep channel. A mixture of litharge and glycerol was used as the cementing material for this purpose. The inverted steel cover *F* fits into the channel of this collar and the seal of the joint is effected, in the usual way, by means of a layer of mercury. The cover *F* is provided with a brass tube *K*, to which the pulley *M* is attached, and

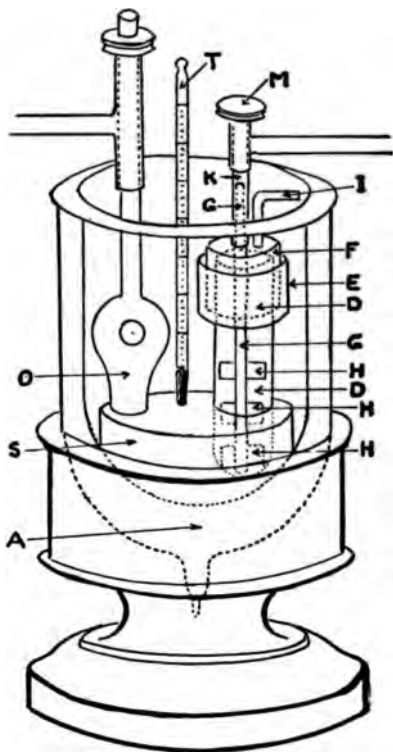


FIG. 9.

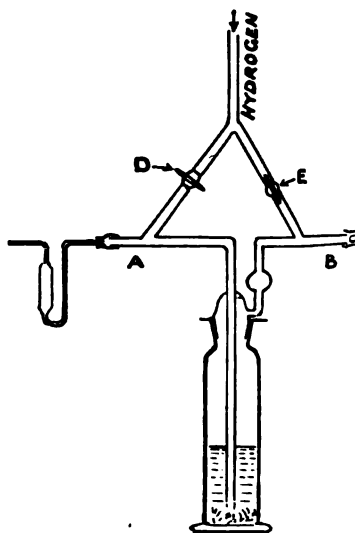


FIG. 10.

is also pierced by the tightly cemented-in glass tube *I*. The glass rod *G*, containing on its lower end the three stirring wings *HHH*, is cemented into the brass tube *K*. The saturating vessel is, for stability, tightly fastened in a hole in a block of lead, *S*, contained in the Dewar cylinder *A*. An atmosphere of  $\text{CO}_2$  in the saturating vessel is provided by introducing  $\text{CO}_2$  under pressure through *I* and allowing the excess to escape through the mercury seal in *E*. After charging the apparatus, *I* is closed with a rubber tube and plug and the stirrers *HHH* set in motion. A Witt stirrer, *O*, keeps the contents of the bath in rapid circulation. Water is



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in the bath for temperatures above  $0^{\circ}$ , and alcohol for those below  $0^{\circ}$ . The regulation of the temperature is accomplished by the use of ice or solid  $\text{CO}_2$  as found necessary and, therefore, requires very close attention on the part of the experimenter.

A novel and simple form of apparatus, which was used by Bahr, for the determination of the solubility of thallium hydroxide at temperatures up to  $40^{\circ}$  is shown in Fig. 10. As will be seen, this

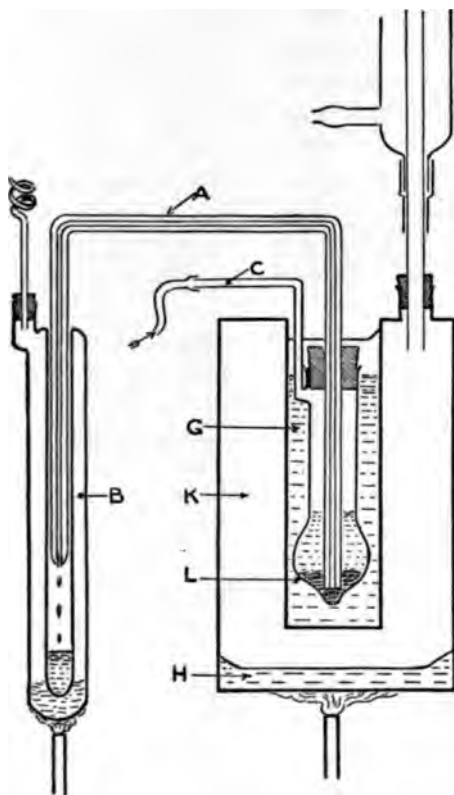


FIG. 11.

consists of a gas washing flask to the arms of which a Y tube provided with two stop-cocks is sealed. The inside walls of the apparatus were coated with hard paraffin and the required amounts of thallium hydroxide and water introduced. It was then immersed in a water bath and the contents stirred by means of a current of hydrogen, which entered as shown and with A and E, passed through D and out at B. When it was desired to



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remove a sample of the solution for analysis, *B* and *D* were closed and the liquid forced through *A* into the pycnometer by means of gas pressure entering through *E*. For temperatures above 40°, the form of apparatus shown in Fig. 11 was used. In this case *K* represents a copper cylinder with double walls, of which the inner compartment *G*, contains concentrated salt solution which is stirred by a stream of air (not shown), and the outer compartment contains a layer of heating liquid *H*. The glass tube *L* contains the mixture of thallium hydroxide and water which is stirred by means of a current of hydrogen (not shown). When saturation is attained the tube *A*, of small bore and thick walls and provided with a small asbestos filter, is introduced and the saturated solution forced over into the receptacle *B* by pressure of hydrogen which enters at *C*. The heating liquid in *B* is the same as used in *H*. The following heating liquids with the boiling points shown were used: Allyl chloride, 46°; Ethylene chloride, 55°; Chloroform, 61°; Methyl alcohol, 66°; Benzene, 80°; Benzene-Toluene mixture, 91°; Water, 100°.

A somewhat more elaborate apparatus, in which the constant temperature is maintained by means of the vapor of a boiling liquid, is shown in Fig. 12. This apparatus was developed by Tyrer (1910) for the very accurate determination of the solubilities of anthraquinone, anthracene and phenanthraquinone in single and mixed organic solvents. The solvent with excess of the solute was placed in *A* and kept in constant agitation by means of the vertically acting stirrer shown. The tube *A* is surrounded by a bath of vapor which circulates through the cylinder *B*, condenses in *C*, and returns to the boiling flask *M*. When the solution is saturated it is allowed to settle, and the clear solution run out (by raising the tube *D*) into a small graduated flask *E*, which is maintained at the same temperature as the solution *A*. The temperature of the vapor bath is varied by changing the pressure under which the liquid in the flask *M* is boiling. For this purpose, the manostat *P* is provided. The temperature can, with care, be maintained constant to 0.01°. For this purpose the apparatus must be air-tight, the liquid in the boiling flask must not bump (which is entirely prevented by placing a layer of mercury in the flask) and a pure boiling liquid must be used.

Although illustrations of special forms of apparatus designed for securing equilibrium in solubility determinations could be extended far beyond the number given, it is believed that the principal features have been made clear and it will no doubt be possible to



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apt the devices here shown to many other cases for which accurate determinations of solubility may be desired.

*Separation of Saturated Solution from Undissolved Solid.*— The at point, after the establishment of equilibrium between the

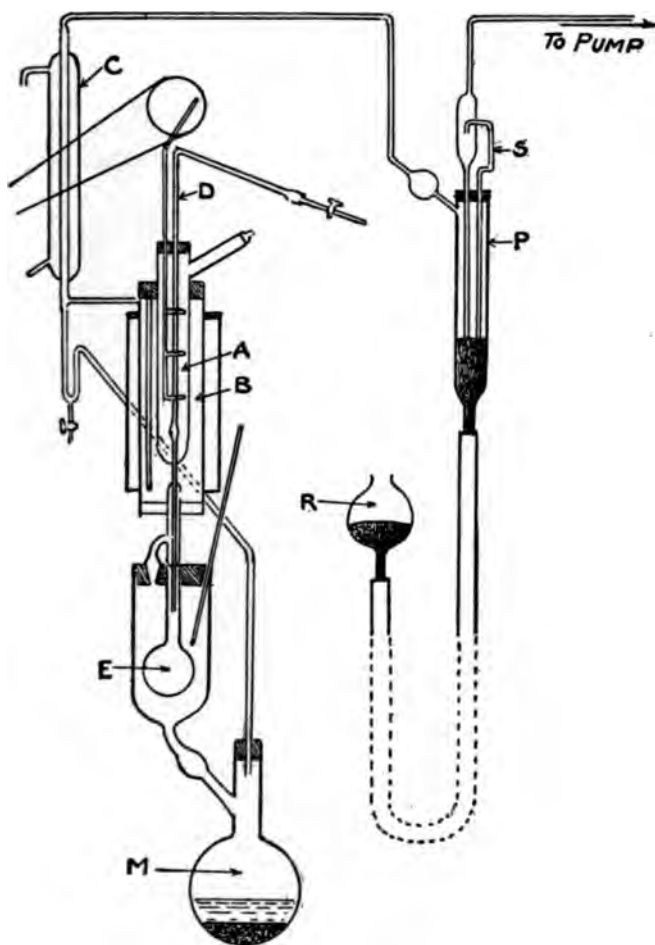


FIG. 12.

vent and solution, is the matter of successfully separating the saturated solution from the undissolved solid, preparatory to its analysis. There are, undoubtedly, many cases where this is a very serious problem. This is especially so for extremely soluble compounds, which yield viscous solutions as well as for those which do not readily settle out of the solution or cannot be removed by



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ordinary filtration. It is, of course, necessary to maintain the mixture at the temperature at which saturation was obtained until the complete separation of the solution and solid has been effected. The operation should, therefore, as a general thing, be conducted in the same bath used for preparing the saturated solution. Several forms of apparatus designed for this purpose are shown in the diagrams given in the preceding pages. For solutions which can be readily separated from the undissolved solid, a graduated pipet to which a stem with a plug of filtering material can be attached and which is adapted to being easily weighed, is the most convenient.

*Analysis of the Saturated Solution.* — The weight of a known volume of the perfectly clear solution, that is, its specific gravity, should always be determined. This weighed quantity of solution, or a known dilution of it, furnishes a very convenient sample for the determination of the amount of dissolved compound.

In regard to the analysis, the procedure must be selected entirely on the basis of the number and character of the constituents present. In cases of the solubility of single non-volatile compounds, in solvents which can be more or less easily removed by volatilization, the plan in most general use is the evaporation of a known amount of the solution to dryness and weighing the residue. Special forms of apparatus to be used for this purpose have been proposed from time to time. These are, usually, vessels with tubular openings, arranged so that a current of dry air can be drawn over the surface of the heated sample.

In the case of solubility determinations in which the saturated solution contains more than one dissolved compound, the application of the usual gravimetric or volumetric procedures will, of course, be necessary. Where unique methods have been developed, a brief reference to them will usually be found in the body of the book, in connection with the results for the compound in question.

In certain cases, where the direct determination of the amount of the dissolved compound present in the solution would be very difficult or impossible, an indirect method can sometimes be used. For this purpose, a carefully weighed amount of the compound must be used, and, after the period of saturation, the undissolved residue is filtered off under conditions which reduce losses to a minimum and, after drying to its original condition, it is weighed, and the amount which has been dissolved found by subtracting the weight of the undissolved residue from the quantity originally present.



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*Identification of the Solid Phase.* — As already mentioned in the chapter on General Information, the solubility of a compound, which is capable of existing in several forms, depends upon the particular form in which it is present in contact with the saturated solution. The question of the composition of the solid phase is therefore, of considerable importance for the accurate determination of solubility. Although the identification of the solid phase presents little difficulty in the majority of cases, it sometimes happens that it can be made only by a more or less indirect method. The principal reason for this is that adhering solution can usually not be completely removed from the solid phase and the analysis, consequently, does not give direct information of the required accuracy.

A method which has been used considerably for identifying the solid phase is that known as the *residue method* of Schreinemakers (1933). It is based on the principle that if an analysis is made of both the saturated solution and of a mixture of the saturated solution and the solid phase of unknown composition, the two points so obtained, when plotted on a coordinate system, lie on a line connecting the point representing the composition of the solid phase and the solubility curve of the system. Similar analyses of another saturated solution of the system and of its mixture with the solid phase, locate another such line. Since all lines so determined when extended, pass through the point representing the composition of the solid phase, their intersection locates this point definitely.

Although the original description of this method by Schreinemakers was illustrated by an example drawn on the rectangular system of coordinates, it has been used much more extensively, in a practical way, in connection with the later developed equilateral triangular diagram. In this case, each apex of the triangle represents one of the three components of the system, each point on a leg, a mixture of two, and each point within the triangle a mixture of all three components. When a number of saturated solutions are analyzed, the results correspond to points on the solubility curve of the system. If now some of the solid phase with adhering solution is removed from each mixture and analyzed, it is evident that the points thus obtained, being for samples made up of both the saturated solution and the solid phase, give points which lie on lines connecting the two. The points on the curve for the pure saturated solutions being known, it is necessary only to connect them with the points for the corresponding mixtures of solid phase and saturated



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solution, and to prolong the lines to their common intersection. This will necessarily be at the point representing the composition of the pure solid phase.

In applying the residue method of Schreinemakers, if the intersecting lines which fix the point corresponding to the solid phase meet at a very narrow angle, definite information as to its composition may not be secured. For cases such as these, a procedure to which the name "*tell-tale*" method was given by Kenrick (1908) and which is described in detail by Cameron and Bell (1910), has been developed. This method consists in adding to the mixture a small amount of an entirely different compound which remains wholly in the solution. After equilibrium has been reached, a portion of the saturated solution and of the solid phase with adhering solution are analyzed, and the quantity of the added "*tell-tale*" compound in each determined. From the result, showing the concentration of the added compound in the saturated solution, and the amount of it found in the mixture of solid and solution, the quantity of solution in contact with the solid can be calculated. Since the composition of the solution is also known, the difference between the composition of the solid plus solution and of the amount of solution known to be present, is the composition of the pure solid.

*Transition Temperatures* can frequently be accurately determined by relatively simple means, and since such data are useful in establishing fixed points on solubility curves they are valuable adjuncts to directly determined solubility data.

*Synthetic Method.*—The procedures which have, so far, been mentioned are all classed as analytical methods of solubility determination. In contradistinction to these is the equally useful reverse process, by which the solvent and solute are brought together in previously measured quantities and the temperature ascertained at which the solution is saturated. To this procedure the designation synthetic method of solubility determination has been applied. One of the earliest investigators to use this method extensively was Alexejeff (1886) and it is, therefore, frequently referred to as the Alexejeff synthetic method of solubility determination.

The synthetic method can, of course, be used both for the solubility of solids in liquids and for liquids in liquids, but it is in the latter case that it is of greatest service. Its points of superiority, particularly in the case of the reciprocal solubility of liquids, are that the upper limits of the determinations can be extended far beyond the boiling point temperature and are, in fact, limited only by the resistance of the glass to pressure or to the action of the



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**liquid.** Only small quantities of the solute and solvent are required for a determination. It is applicable to compounds for which quantitative methods of analysis are not available or are of a tedious character. The mixtures, being contained in sealed tubes, are not subject to the action of constituents of the air, nor are losses, due to volatilization, to be feared. Although, in the case of solids, difficulties incident to the supersaturation, resulting from failure of the crystals to separate on cooling, are encountered, with liquids the point of saturation is made instantly and strikingly evident by the beginning of opalescence or clouding which occurs, and errors due to supersaturation are rarely encountered. A sure criterion that supersaturation does not occur rests on the observation of the temperature at which the cloudy solution again clears. If this temperature coincides with the temperature of the beginning of opalescence, it is certain that supersaturation has not occurred. The observation of the temperature of saturation can be repeated as often as desired, and the accuracy of the determination is ordinarily limited only by the care taken in making it.

The limitations of the method, aside from the supersaturation which may occur in the case of solids, are principally those resulting from the low temperature coefficients of solubility possessed by certain compounds, and which usually occur in the vicinity of maxima or minima of solubility curves. Although a "critical clouding" occurs in the vicinity of the so-called critical solution point, this possesses a characteristic appearance which is easily distinguishable from the clouding observed at the saturation point, and errors of observation due to it are not to be apprehended. In fact, it has been pointed out that supersaturation disappears at the critical point, and the synthetic method is ordinarily very accurate in the vicinity of the critical solution temperature.

Since, by the synthetic method the results are necessarily obtained under different pressures, this question has been given consideration from the theoretical and the practical side. Although it is possible that extremely high pressures would exert an influence, the conclusion appears justified that under ordinary conditions, in which pressures of 10 atmospheres are not exceeded, no notable effect would be produced. The solubility curves obtained by this method do not show any abnormalities due to this cause.

In the case of the determination of the solubility of solids by the synthetic method, the operation consists in preparing a mixture of a carefully determined amount of the solvent and of the solid, and subjecting it to gradually increasing temperature and to constant



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agitation, while a continual observation of the changes taking place in the solid is made. When all but a few small crystals have dissolved, the change in temperature is regulated much more carefully and note is taken of the point at which the edges of these final crystals begin to change from sharp to rounded, or vice versa, or where the sizes of the particles visibly increase or diminish. Care must, of course, be taken not to allow the last portions of the solid to dissolve; otherwise, on cooling, considerable supersaturation may occur before the solid begins to separate from solution. The method is, naturally, most serviceable where the change in solubility with temperature is considerable, and where convenient methods for the direct analysis of the solution are not available.

The procedure of a determination in the case of the reciprocal solubility of liquids consists in introducing by means of capillary funnels weighed amounts of the two liquids into small glass tubes and sealing the ends. The amount of air space in the tubes should be kept low. Many convenient devices for weighing and introducing the liquids have been described. In the case of very volatile liquids it may be necessary to introduce them in thin walled bulbs, which can be broken after the tube containing the mixture has been sealed. The tube is then placed in a large beaker of water, or higher boiling liquid if necessary, and heat applied until the contents of the tube, on being shaken, become homogeneous. The temperature is then allowed to fall very slowly and an observation made, while the tube is constantly agitated, of the temperature of first appearance of opalescence. This observation can be repeated as many times as desired and the temperatures of appearance and disappearance of the clouding, which usually differ by only a few tenths of a degree, can be ascertained with certainty.

Since, by the synthetic method the data are for irregular intervals of temperature, in order to obtain results for a particular temperature it is necessary to plot the several determinations on coördinate paper and from the solubility curve so obtained, read the value for the temperature in question.

*Freezing-point Method.* — A modification of the synthetic method, which is applicable particularly to solutions which contain relatively large amounts of the dissolved compound, is that which consists in a determination of the freezing-point of the mixture. This point is, in fact, the temperature at which the separating solid compound is in equilibrium with the solution.

The difference between the freezing-point determination and the observation of the point of growth or diminution of a crystal in a



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liquid is that, in the former, the establishment of equilibrium is recognized exclusively by the change of the thermometer. The solution is cooled gradually, during which the thermometer sinks slowly to a point below the freezing temperature. As soon as the first crystal appears, either spontaneously or by intentional introduction (seeding), the thermometer rises suddenly to the freezing-point and remains stationary for some time.

This method can, of course, be used in a large number of cases for the determination of solubility. Those portions of the solubility curves of salts in water for which ice is the solid phase, are practically always determined in this way and it may be said, in general, that for determinations made at low temperatures, the freezing-point method is to be selected whenever possible.

For the practical execution of the method the very well known apparatus of Beckmann is most convenient and satisfactory. The determinations must, of course, be made with all the refinements which have been developed for accurate freezing-point measurements.

The method has been used extensively for the discovery of addition compounds. Its use for this purpose is based upon the principle that if to a pure compound, *A*, a second, *B*, is added, the freezing-point of *A* is lowered; similarly the freezing-point of *B* is lowered by *A*, and the two descending curves thus obtained intersect at the eutectic. If, however, a compound, *A<sub>x</sub>B<sub>y</sub>*, is formed, this also acts as a pure substance and its freezing-point is lowered by either *A* or *B*. Hence the freezing-point lines do not meet at a single eutectic but exhibit in this case a maximum, the position of which indicates the composition of the compound.

*Volume Change Method.* — Still another method, which is a modification of the synthetic, is that designed to indicate the reciprocal solubility of liquids by a determination of the volume changes which occur when two relatively sparingly miscible liquids are shaken together in a closed vessel. The apparatus consists usually of a cylindrical receptacle which is provided with a constricted graduated section either at one end or near the middle. Such volumes of liquids are chosen that the meniscus separating them lies in the constricted graduated tube. The determination consists in superimposing measured volumes of each liquid and noting the position of the meniscus before and after a period of shaking at constant temperature. From the increase or decrease of volume of the two layers, as estimated from the change in position of the meniscus, the reciprocal solubility of the two liquids is calculated. It is to be



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noted, however, that the solubility of liquids is in practically all cases reciprocal, and without an analysis of the two layers the true solubility can not usually be deduced.

*Titration Method.* — A special case of the reciprocal solubility of liquids is that representing equilibrium in ternary systems yielding two liquid layers. Such equilibria are usually determined by relatively simple titration procedures, but for the interpretation and description of the results, special terms have been developed and these require more or less detailed explanation.

When a third liquid is added to a mixture of two others which are miscible to only a slight extent, the added liquid, if soluble in each of the others, will distribute itself between the two and an equilibrium will be reached. If the two layers are then analyzed and the results plotted on coördinate paper, two points, corresponding to the two layers, will be obtained. If more of the third liquid is added, equilibrium will again be established after a short period of shaking and the analysis of the two layers, to which the designation *conjugate* layers has been given, will fix two more points when plotted on the coördinate paper. The process may be repeated until a considerable number of points have been obtained. When this has been done, it will always be found that these points are the locus of a smooth curve, to which the designation *binodal* curve has been given. If the pairs of points corresponding to the conjugate layers are connected, the lines so obtained are defined as *tie lines*. Since it is evident that with the continued addition of the third or *consolute* liquid, a point must finally be reached at which the resulting mixture will no longer separate into two conjugate layers, the tie lines successively determined as above described, will become shorter and shorter until finally the last one is reduced to the point corresponding to the homogeneous mixture of the three components. To this is given the name *plait point*.

Although for the above example a ternary system made up of three liquids has been taken, there are a large number of salts and other solid compounds which, when dissolved in mixtures of liquids of certain concentrations, cause the latter to separate into conjugate liquid layers. These systems have aroused much interest from time to time and considerable data for them are given in the literature.

Since it is usually difficult and frequently impossible to analyze directly a homogeneous mixture of liquids, and thus determine the points on a binodal curve, a simple titration method for this purpose has come into general use. By means of this a homogeneous mixture of known amounts of two of the components is titrated with



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The third just to the point of initial separation of the second layer, which is usually very sharply indicated by the appearance of clouding or opalescence. The procedure may also be reversed and the insoluble liquid added just to the point of clearing of the cloudy mixture of the other two. By this plan the synthetically derived composition of one of the two conjugate layers and thus of one point on the binodal curve is known. The determination of the tie line and therefore, the identification of the corresponding point on the curve for the conjugate liquid, requires an additional experiment or its location. Several procedures for this purpose have been developed. They usually depend upon the determination of one or more constants of specially prepared pairs of conjugated liquids, such as their specific gravities or refractive indices. In the case of mixtures of which one member can be easily determined analytically, tie lines can be located by the quantitative determination of this member in pairs of conjugated liquids.

In general, the titration method for the determination of the solubility of liquids is applicable to many cases. The facts, that equilibrium is attained so promptly in liquids and that the evidence of the appearance of a second insoluble layer is usually so striking, make it of great value. Refinements have been introduced such as the addition of liquid or solid dyes to the mixture in order to facilitate the detection of the end point, and the development of particular forms of apparatus for measuring and weighing the liquids. The constituents of the mixtures are usually weighed but the volume relations and, therefore, the specific gravities can also be approximately estimated, by using graduated vessels for making the titrations, and measuring in them the volumes of the final mixtures. A very ingenious method for ascertaining indirectly the composition of the liquid mixtures in the case of the system naphthalene, acetone and water, is described on p. 444.

As a usual thing the temperature coefficients are not very great in the case of liquid mixtures and the very accurate control of the temperature is not imperative. When such control is necessary, however, the use of a thermostat does not seriously complicate the determination.

*Distribution Coefficients.* — As mentioned above, when a third compound is added to a mixture of two liquids which are relatively immiscible, it will dissolve to a certain extent in each and the composition of the two layers represent conjugate points on the binodal curve for the system. The results are, however, of interest from another point of view, namely that of the distribution of the com-



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pound between the two solvents. This distribution coefficient is, in many cases, of considerable interest in connection with analytical methods based on shaking out procedures and also in connection with such problems as the molecular state of compounds in solution, their dissociation and other points of theoretical interest. Distribution coefficients have, therefore, been studied to a large extent and much data for them are available. In general, the determinations are made by relatively simple methods. The amount of the compound present in a definite amount of each layer, after equilibrium has been established by adequate agitation, is determined in any manner most convenient. If the total amount of solute is known, and that found in one layer, the amount in the other can, of course, be calculated by difference. The results are usually expressed on the volume basis, since it is the ratio of the amounts present in the same molecular state in equal volumes of the two layers which is a constant, independent of temperature and concentration.

It is evident that when the concentration at the saturation point is considered, the amount of the compound which enters each layer depends upon its solubility in the liquid, consequently the distribution coefficient is the relation of the solubilities of the dissolved substance in the two solvents. Variations from this, aside from changes in molecular state, etc., in one or the other solvent are due to such causes as the reciprocal solubility of the so-called immiscible solvents, which will, of course, be influenced by the presence of the dissolved compound, especially at the higher concentrations. Variations of the coefficient with temperature would result in cases where the solubilities of the compound in the two solvents do not change at the same rate with temperature.

*Electrolytic Conductivity Method.* — Of the physical properties which can be used for the determination of the concentration of a solution, such as specific gravity, refractive index, etc., the electrolytic conductivity is of particular value in the case of those very sparingly soluble compounds which yield solutions too dilute to be analyzed by gravimetric or volumetric methods. By its use the progress of the saturation can be followed without separating the undissolved solid from the solution, or even removing the portion used for the determination. The special electrical equipment which is required, however, and the need for water of exceptional purity and of vessels of particular qualities, restrict its general use.

The method of calculating the concentration from the conductivity is based on the assumption that at the very great dilutions



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involved, complete dissociation occurs. Therefore, the limiting value to which the equivalent conductivity approaches at infinite dilution is, for practical purposes, attained, and  $\Lambda = \Lambda_{\infty} = l_a + l_k$ , where  $l_a$  and  $l_k$  are the ionic conductivities of the anions and cations. These values are known for all the principally occurring ions. The observed specific conductivity  $\kappa$  is, however, connected with the equivalent conductivity and the concentration  $\eta$  by the equation

$\Lambda = \frac{\kappa}{\eta}$ , in which  $\eta$  represents the concentration in gram-equivalents per cubic centimeter. Rearrangement and substitution give

$\eta = \frac{\kappa}{l_a + l_k}$ . From this equation the solubility of the substance under investigation is calculated by substituting the measured specific conductivity of the solution and the known values of the ionic conductivities.

*The Solubility of Gases in Liquids.* — When a gas and a liquid are intimately mixed by shaking, a definite amount of the gas will be dissolved by the liquid and, simultaneously, the vapor of the liquid will mix with the gas in the space above the liquid. The partial pressure of the liquid in the gas space is almost exactly the same as that of the pure liquid at the solution temperature, since the influence of the relatively slight amount of dissolved gas is insignificant in by far the most cases. The amount of gas which is dissolved depends both on the nature of the gas and of the liquid and is, furthermore, a function of the temperature, and pressure.

In regard to the influence of pressure, the absorption law of Henry holds for the most part, when the gas solubility is not too great. According to it, the amount of pure gas, which is taken up at constant temperature by a given amount of liquid is proportional to the pressure of the gas.

The temperature acts almost always in the sense that the solubility decreases as the temperature rises.

The solubilities of gases are usually expressed either in terms of the Bunsen "Absorption Coefficient"  $\beta$ , or the Ostwald "Solubility Expression"  $l$ . Definitions of these are given on p. 227.

The experimental methods for the determination of the solubility of gases vary according to the nature of the gas. For those which dissolve in relatively large amounts and can be analytically determined with accuracy, the saturated solution may be analyzed by ordinary quantitative methods. Thus, in the case of the solubility of sulfur dioxide in aqueous solutions of salts (see p. 706, results by Fox, 1902), the solutions were saturated by passing a stream of the



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gas through them at atmospheric pressure and, when equilibrium was attained, a measured portion of the solution was withdrawn, transferred to an excess of standardized iodine solution and the excess of the latter titrated with thiosulfate. A gravimetric procedure was used by Christoff (1905) for the determination of the solubility of carbon dioxide in aqueous salt solutions. In this case the solutions were weighed before and after the passage of the gas through them and the increase in weight, after applying necessary corrections, taken to represent the solubility at the temperature of the experiment and at atmospheric pressure. The absorption flasks were of special shape and the gas was previously passed through a series of U tubes, containing the same aqueous solution, in order to prevent loss of water from the experimental solution which, otherwise, would have occurred.

In the great majority of cases, however, gas solubility is determined by a method based upon the measurement of the volume of the gas absorbed. The apparatus consists essentially of an absorption flask for the liquid, connected by means of a tube of small bore to a graduated buret in which the gas is measured above mercury, the level of which can be altered by raising or lowering a container connected with the buret by means of a rubber tube. Many forms of this apparatus have been described and the disadvantages of the earlier forms have gradually been remedied. A relatively simple form of this apparatus, but one which embodies the essential features required for accuracy, is that described by McDaniel (1911) for the determination of the solubility of methane, ethane and ethylene in a large number of organic solvents at various temperatures.

This apparatus is shown in Fig. 13. *A* is an ordinary gas buret and *B* an absorption pipet of the form first used by Ostwald. "The buret and pipet are connected by means of the glass capillary *M* sealed directly onto each, so that the whole forms one solid piece of glass apparatus *without rubber or cement connections of any kind*; thus any possibility of leaks from these extremely troublesome sources is entirely avoided. The whole apparatus is clamped solidly to a rigid support so that it can be taken up in the hands and shaken for the purpose of bringing the gas into intimate contact with the liquid. The pipet and buret are each provided with a three-way stopcock, *C* and *D*. These can be turned in such a way as to allow the gas to sweep out the air from the connecting capillary. By the same means the two vessels may also be connected directly with each other as well as separately with the outside air or source



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gas supply. The pipet and buret are each provided with a water jacket, *P* and *Q*. The temperature of each is regulated by means of the electrically heated coils *K* and *L*. These coils are of manganin wire and are connected in series. The rate of evolution of heat in the jackets was adjusted in the first place by varying the length of the manganin wire, until the temperature was the same in each jacket. Stirring was accomplished by blowing air through tubes *I* and *J*. The differences in temperature between the pipet and buret were never greater than  $0.1^{\circ}$ .

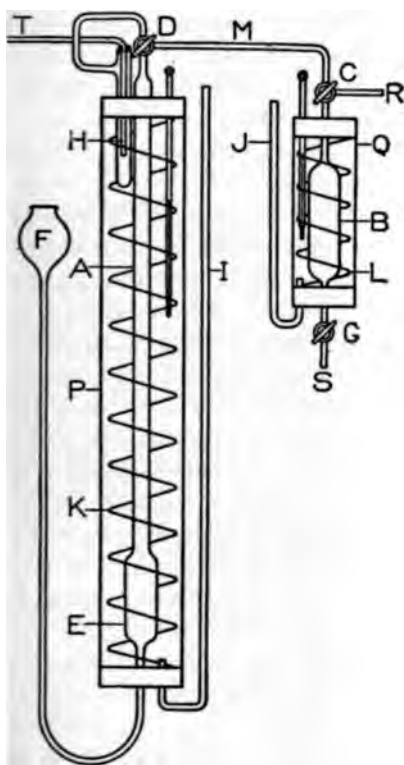


FIG. 13.

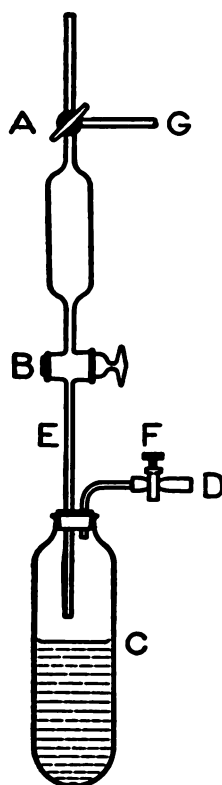


FIG. 14.

in carrying out a determination by this method it is, of course, necessary that the solvent be completely free of dissolved air or other gas. This is perhaps the most important part of the determination and a special form of apparatus for the purpose is described by McDaniel (1911) and is shown in Fig. 14. "The liquid was removed under diminished pressure in the flask *C* attached directly



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to the lower opening of the pipet by means of the rubber stopper as shown in the figure. Connection with the air pump is made at *D*. During the boiling the lower opening of the inlet tube *E* is above the surface of the liquid in *C*, the stopcock *B* being closed. When the air has been completely expelled, the screw pinchcock *F* is closed while the air pump is still in operation. The flask *C* is now raised until the lower end of *E* reaches nearly to the bottom of the flask. The air pump is now connected at *G* and the cock *H* opened so as to make connection with the pipet. *B* is now opened and the inflow of air through *D* regulated by gradually opening *F* in such a manner that the liquid is very slowly forced up into the pipet. In this manner the liquid never comes into contact with the air under full atmospheric pressure but only under greatly diminished pressure. The absorption of air under these conditions can only be inappreciable, especially since the liquid in the flask remains perfectly quiet, and only the lower portion is used."

Having filled the pipet *B*, Fig. 13, with the air-free solvent as just described, "*T* is connected with the source of gas supply and the cocks *C* and *D* are turned in such a way as to allow the gas to sweep out the air from the capillary, *M*. The buret is then filled in the usual manner by lowering the leveling tube *F*, the cock *D* having been turned so as to connect *T* with *E*. Care is taken to keep the entering gas under a slight pressure by keeping the mercury level in *F* slightly above that in *A*. This prevents air from entering through any leaks in the train connecting the gas generator with the buret." The gas must be completely saturated with the vapor of the solvent and this, with other than aqueous solvents, may require, in addition to drawing it through some of the solvent in *H*, that a thin layer be placed in the buret and time allowed for it to saturate the gas sample.

"After again allowing the current of gas to flow through the capillary *M* for a short time the buret and pipet are connected with each other by turning the three-way cocks *D* and *C* in the proper direction. The determination of the amount of absorption is then made as follows: A portion of the gas is passed into the pipet by raising *F* and opening *G*, the displaced liquid being caught in a graduated cylinder. The cock *C* is closed and the gas and liquid in the pipet brought into intimate contact with each other by shaking the whole apparatus. *C* is now opened to allow gas to enter from the buret to replace that absorbed. This process is repeated until, on opening *C*, there is no further decrease in the volume of gas in *A*. The volume absorbed is found by subtracting from the original



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volume of gas, the volume remaining in the buret plus the volume in the pipet. The volume of gas in the pipet is equal to the volume of liquid drawn off. The volume of liquid remaining is easily calculated from the known volume of the pipet. The absorption coefficient or 'solubility' is the ratio of the volume of gas absorbed, measured at the temperature of the experiment, to the volume of the saturated liquid. It may be reduced to the coefficient used by Bunsen by dividing by  $(1 + \alpha t)$ ."

In the case of the majority of investigators who have used this method, particularly for determinations at high or low temperatures, the absorption pipet has been kept at the temperature of the experiment and the gas measuring buret at room temperature, the two being connected by means of a flexible capillary which permits the absorption pipet to be independently shaken. This arrangement makes it necessary, in calculating the absorption coefficients, to apply the usual corrections for temperature and vapor pressure to the volume of gas in the buret. This is a complication which in some cases causes uncertainties in regard to the accuracy of the results as finally calculated.

A somewhat more elaborate form of apparatus than that just described was developed by Drucker and Moles (1910) for determinations in cases where the solubility is very small. These authors give results for hydrogen and nitrogen in aqueous solutions of glycerol. The particular feature of the apparatus is that only about one-tenth the usual amount of solvent is employed and solubilities as low as only one-tenth that of nitrogen in water at 25° can be measured.

An apparatus designed for determinations at very high pressures, using a Caillet compression tube, is described by Sander (1911-12). It was used for determination of the solubility of carbon dioxide in water, alcohols, and other organic solvents. The principle involved is that the pure gas is first compressed above mercury in a graduated tube and the volumes corresponding to given pressures noted. Similar readings are then taken for the same gas after a small accurately measured amount of solvent has been introduced into the graduated tube. The difference between the two volumes at the same temperature and pressure, reduced to 1 kg. per sq. cm. and 1 cc. of liquid, represents the solubility of the gas in the given solvent.

Finally, attention should be called to the method of determination of gas solubility based on the principle that, for volatile solutes which obey the laws of Dalton and Henry, the amount which is carried away by an inert gas when known volumes are bubbled



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through solutions of known strength of volatile solute, can be used to measure the comparative solubilities in solvents of different concentrations. An example of this method is the determination of the solubility of ammonia in aqueous salt solutions by Abegg and Riesenfeld (1902). The very ingenious apparatus consists of a generator for developing a stream of  $H_2 + O_2$  from aqueous NaOH, by means of an electric current measured with the aid of a copper voltmeter, and the volume of gas thus determined. This was passed through a spiral in the vessel containing the ammonia solution of known concentration. The mixed gases passing out of this were received in a third vessel containing 5 cc. of 0.01 *N* HCl. Electrodes were provided in this vessel and, by means of conductivity measurements, the point determined at which all of the HCl became saturated with  $NH_3$ . Since the volume of the  $H_2 + O_2$  required for this purpose was known, the partial pressure of the  $NH_3$  in the mixture could be directly ascertained. Comparative determinations of the vapor pressure of the ammonia in water and a series of salt solutions made in this way were calculated to ammonia solubilities on the basis of the relation that, for two solutions of equal ammonia content, the ammonia pressure is reciprocally proportional to the solubility of the ammonia in them.



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abbreviations of the names of the journals referred to in this index agree, most part, with those adopted for Chemical Abstracts. They will, therefore, be readily understood in all but a few cases. One abbreviation which differs from that used in Chemical Abstracts is Proc. k. Akad. Wet. (Amst.) instead of Proc. d. Sci. Amsterdam. It refers to the English edition of Verslag koninklijke Wetenschappen te Amsterdam.

Another abbreviation which has been adopted for the present index is the use of "Tables annuelles" for the French title, Tables annuelles de Constantes et de Numerique de Chemie, de Physique et de Technologie, of the International Tables of Constants and Numerical Data published in Paris under the direction of the general secretary, Professor Marie. Of the three volumes which have been published, Vol. 1 contains data for the year 1910 and was issued in 1911; Vol. 2 for the year 1911 and appeared in 1913; and Vol. 3 contains data for the year 1912 and was issued in 1914.



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	1900	1901	1902	1903	1904	1905	1906
Am. Chem. Jour. (*)	23-4	25-6	27-8	29-30	31-2	33-4	35-6
Am. Jour. Pharm. (*)	72	73	74	75	76	77	78
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J. Phys. Chem. (*)	4	5	6	7	8	9	10
J. physique (†)	<sup>13</sup> 9	10	<sup>14</sup> 1	2	3	4	5
J. prakt. Chem. (†)	<sup>1-1</sup> 61-2	63-4	65-6	67-8	69-70	71-2	73-4
J. Russ. Phys. Chem. Soc.	32	33	34	35	36	37	38
J. Soc. Chem. Ind. (†)	19	20	21	22	23	24	25
Mem. Coll. Sci. Eng. Kyoto <sup>2</sup> (*)	.....	.....	.....	1	.....	.....	.....
Monatsh. Chem. (†)	21	22	23	24	25	26	27
Pharm. Jour. (Lond.) (*)	64-5	66-7	68-9	70-1	72-3	74-5	76-7
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Rec. trav. chim. (*)	19	20	21	22	23	24	25
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Z. physiol. Chem. (†)	30-1	31-4	34-7	37-40	40-43	43-46	47-50

<sup>1</sup> Changed to Ann. chim. in 1914.

<sup>2</sup> Changed to Mem. Coll. Sci. (Kyoto) in 1914.



# of Publication of Fifty Chemical and Related Periodicals.

the case of those marked (†), the tables of contents only were searched. The of the last complete volume examined.)

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